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August 10, 1931

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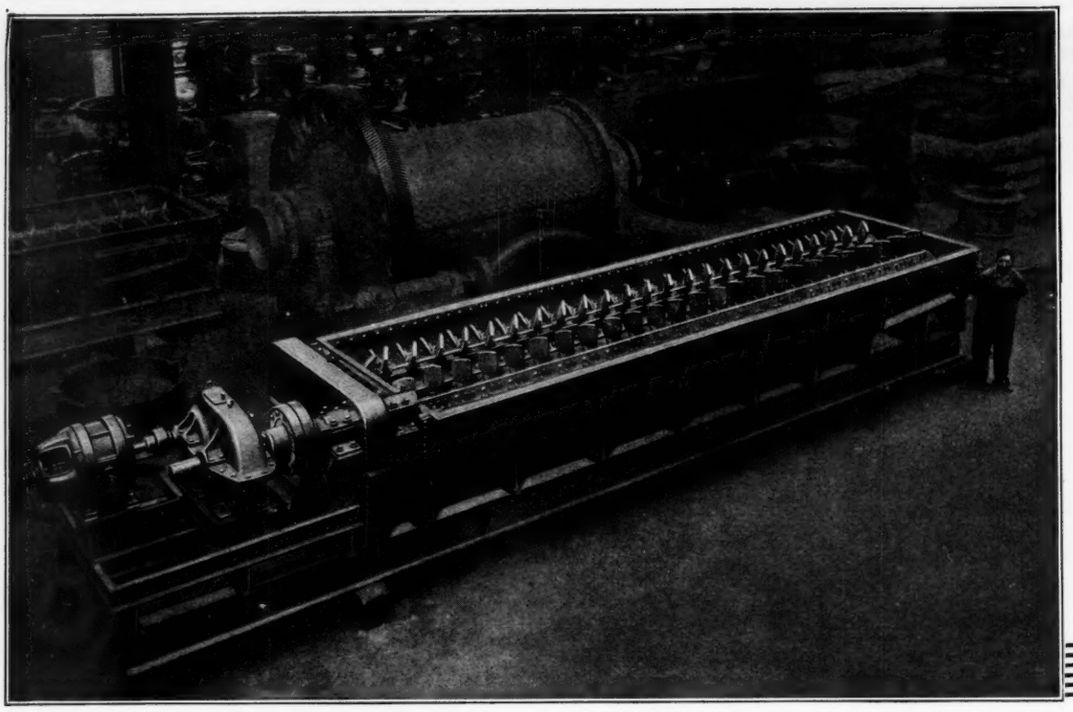

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Engineering and Mining Journal

August 10, 1931 A. W. ALLEN, *Editor* Vol. 132—No. 3

To Bisbee—the First Fifty Years Are the Hardest

IN THE SAME YEAR that sees the famous and fecund camp of Bisbee celebrate the fiftieth anniversary of its founding, a merger of its two largest operating mines is proposed. If Phelps Dodge unites with Calumet & Arizona—and there seems to be every indication that it will—Bisbee will follow a path similar to that which has taken Butte into the ranks of one-company mining districts. Other mining companies are operating in Bisbee, but at present only one—Shattuck Denn Mining—is of importance, and its production is dwarfed by the united output of the two merging concerns.

Bisbee's production was almost static for several years before the boom of 1929 raised it to more than 90,000 short tons of copper per annum. In 1930 output dropped back to about 65,000 tons; the 1931 rate is probably not more than 50,000 tons annually. When summaries of copper reserves in the United States are made, Bisbee is nearly always included among the camps that are described as declining. The exhaustion of the ores that could be mined by open-pit methods at the famous Sacramento Hill has led to an impression that Bisbee's days are numbered.

The merger, if it is consummated, will probably result in a more intensive exploitation of the high-grade resources of the Campbell orebody, now owned by Calumet & Arizona. Because of its desire to co-operate in correcting overproduction of copper during the last two years, this company has never had an opportunity to determine the results that might be achieved by large-scale capacity operation of the deposit, discovered in 1926 but not really put into condition for big-tonnage production until last year, when the Campbell shaft was equipped for hoisting. By the merger, Phelps Dodge could, if it desired, transfer miners to the Campbell unit and shut down operations at its leaner deposits, reserving them for better days and better copper prices.

The Campbell is not the only new high-grade deposit in Bisbee. Early this year, drilling at the Denn mine of the Shattuck Denn Mining was reported to have struck a sensational width of high-grade ore below the present 2,200 level workings. Part of this ore runs into Calumet & Arizona ground. Although drilling has been continued, the company has not yet made announcement of additional results, but it is considering sinking its shaft to 2,600 ft.

At the time the Calumet & Arizona absorbed its Ajo subsidiary, New Cornelia, in 1929, Mr. Gordon Campbell, then president of the company, pointed out that half of its Bisbee holdings was still virgin ground, as far as underground development was concerned, although the company has been working for thirty years. Phelps Dodge has by no means exhausted the possibilities of its Warren shaft territory, where extensive exploration has been mapped out. The character of the orebodies at Bisbee is such that ore reserves cannot economically be blocked out for more than a few years in advance.

Bisbee celebrates its fiftieth anniversary with the distinction of having been exceeded, in total copper production, by only four other districts in the United States—Michigan, Butte, Globe-Miami, and Bingham. The longevity of mines being a subject on which conflicting opinions are held, *Engineering and Mining Journal* would probably do well to withhold prediction and prognostigation, but it cannot allow this opportunity to pass without wishing the camp fifty additional years of production even more prosperous than those that have elapsed.

To a Pioneer in Hydrometallurgical Research

THE College of Mining of the University of California, at Berkeley, was developed by Samuel Benedict Christy and his associates when Western mining was flourishing. Professor Christy, in addition to demonstrating ability as a teacher, evinced keen interest in metallurgical research. His paper on "The Solution and Precipitation of the Cyanides of Gold," published by the A.I.M.E. in 1899, with its electromotive series of metals and minerals, is still a classic in hydrometallurgical literature.

A bond between professor and student is established by day-to-day contact. Relatively few students graduate without having acquired an abiding respect for their instructors. Some concentrate their loyalty on one professor, whereas others of broader sympathy hold most of their teachers in high regard—one of the compensations to those engaged in university work.

Professor Christy's students have played and are playing an important part in the mining industry and in the affairs of the nation. Some have gone on the long journey; others have retired to well-earned leisure; many are still in the full tide of accomplishment. To their credit be it said that when the idea of a memorial was suggested, the wherewithal was speedily forthcoming. In the Greek Theater at Berkeley, in the midst of other tributes to departed teachers, a place has been found for a symbol to represent the affection and regard in which the memory of Samuel Benedict Christy is held by his university pupils and associates.

Zinc Institute Follows Product Beyond Ingot Stage

A RECENT ANNOUNCEMENT deserves more than passing attention. The American Zinc Institute, in order to broaden and develop existing markets for galvanized products, the largest single outlet for zinc, has launched a campaign to eradicate some of the undesirable features in the manufacture and distribution of this commodity. The most significant step in this campaign is the adoption of a "Seal of Quality," to be used by manufacturers of galvanized sheets, under a license system.

Extensive studies conducted by the Institute and other technical organizations have revealed the fact that the dominant factor in determining the service of galvanized sheets is the thickness, or weight, of the zinc coating. This fact, which may seem almost too evident to stress, has, however, never been given sufficient prominence. Commercial galvanized sheets of today present a great variety of coatings, and the result has been that ignorant or negligent producers have at times brought discredit to a product that, when correctly manufactured, has its own distinct field of usefulness.

License arrangements for the "Seal of Quality" are now being concluded with manufacturers. Every sheet made under this arrangement will be stenciled with the seal, with the weight of the zinc coating in ounces per square foot, and with the manufacturer's name or trademark. The Institute is also conducting an educational campaign among dealers and consumers to bring to their attention the important facts regarding galvanized products, and to enable them to select weights of coatings suitable for their specific needs.

The logic and soundness of this procedure should leave little doubt as to its success in stimulating the demand for galvanized products. It must also be hailed as another indication that the smelters and refiners are awakening to the importance of following their products beyond the ingot stage.

Ore-Dressing Plants and Construction Materials

IN A RECENT ISSUE of this publication appeared an interesting and valuable article that disclosed how one mining company had made provision for diversification to meet almost any eventually; how it had succeeded in weathering the depression. This was achieved by designing and erecting an efficient ore-reduction plant that would also be available for the production of graded rock for construction purposes. In this innovation may be discerned the germ of an idea of significant import to the mining industry. Many mining properties are situated in isolated regions served by roads that are badly in need of reconstruction. Modification of an idle crushing plant, the addition of some up-to-date machinery, a change in flowsheet, plans for the mining of stone in a near-by quarry, and its transportation—and the means are at hand to supply the concrete mixer with its major requirement. The millman knows his equipment, its scope and limitations; he is well qualified to supply, at minimum cost, graded rock and clean sand products. If state authorities will provide the funds, work can be found in many districts for idle hands and idle machinery, and the further development of mining regions will be facilitated by the provision of better roads.

Mr. Arthur Notman, in a recent issue of *Mining & Metallurgy,* touched on the same subject in a plea for the investment of substantial sums in regions where wages are low and wants are few, for the construction of automobile roads and railways. He reminded his readers that more than half the population of the world lives in such areas, adding that "If those people were employed on such projects at somewhat higher wages than they have heretofore received, it would not be long before they would be making use of these facilities in automobiles and trains purchased from the industrial nations, and consuming the oil and other supplies furnished by the invested capital of those nations. The human race has an insatiable appetite for better transportation whenever and wherever it is made attainable. This offers a solution," Mr. Notman rightly contends, "for the use of the excess capacities which we have built up, and protection for the investments therein."

Economic Conditions and the Gold-Mining Industry

WIDESPREAD ATTENTION is being focused on the many opportunities offering in the development of abandoned gold properties, in the treatment of low-grade ore and residue dumps. Technical help is needed, but the contention is truer today than when it was advanced a decade ago that the specialist in this field seems to keep himself in the background, although he is entitled, by experience and knowledge, to a share of the recognition accorded to mining engineers as a body. From all points of the compass come demands for technical advice on the many problems that confront the operator, especially of the small property.

Thousands of small mines are being developed or could be developed by non-technical operators, who need an impartial opinion on treatment methods and equipment and who are at a loss how to proceed. Such an individual may turn to the technical press to find that recent practice is exemplified at one property by the retention of amalgamation as a preliminary to cyanide treatment, whereas in another instance he finds that it has been discarded; elsewhere he discovers that a reversion has occurred toward bulk leaching, with apparently efficient results. Flotation and gravity concentration each play a part in other flowsheets. The explanation of the apparent want of agreement is that each ore has its own characteristics; but one finds that identical ores are being treated by fundamentally different methods. The disparity is due to the personal equation and to the influence of research, to the need for lower residues and minimum costs.

The small gold-mine operator is looking for a type of service that seems to be lacking, but which could be supplied by many technicians now seeking positions as operators, technicians whose broad and successful experience as engineers, chemists, and metallurgists entitles them to consideration as consultants in the field in which they have specialized.

The Empire Zinc Company's Operation at Gilman, Colorado

Prepared by the technical staff of Empire Zinc under the direction of

W. O. Borcherdt

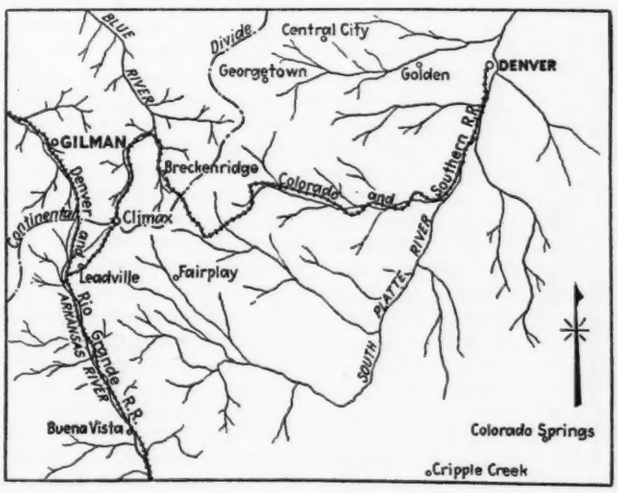
Painstaking examinations, continuous since 1912, resulted in the consolidation of idle properties and the development of an economical and efficient technique of mining practice, described in this article—the first of a series on the operations of The Empire Zinc Company, a subsidiary of The New Jersey Zinc Company. The second, describing the underground mill, will prove of great interest to metallurgists and mill designers.

THE Eagle mine of The Empire Zinc Company, a subsidiary of The New Jersey Zinc Company, is at Gilman, Colo., in the Battle Mountain mining district, 27 miles west of Leadville. Gilman, on Battle Mountain, with an altitude of 8,975 ft., lies along the Pikes Peak or Ocean-to-Ocean Highway—the lowest route over the Continental Divide to western Colorado. Below Gilman, in the Eagle River Canyon, along the main line of the Denver & Rio Grande Western Railroad, is Belden, at an altitude of 8,370 ft. A surface tramway, 1,300 ft. long, with an average slope of 23 deg., connects Belden with Gilman.

Claims were first located on Battle Mountain in 1879. The outcrops consisted of small areas of gossan and iron-stained limestone exposed in the gulches and on the hillside, along the porphyry limestone contact. Similarity of the formations and outcrops to those of Leadville no doubt encouraged development. Profitable oxidized lead-silver orebodies were developed almost from the grass roots, and the size and extent of the deposits were greater than the small surface showings promised.

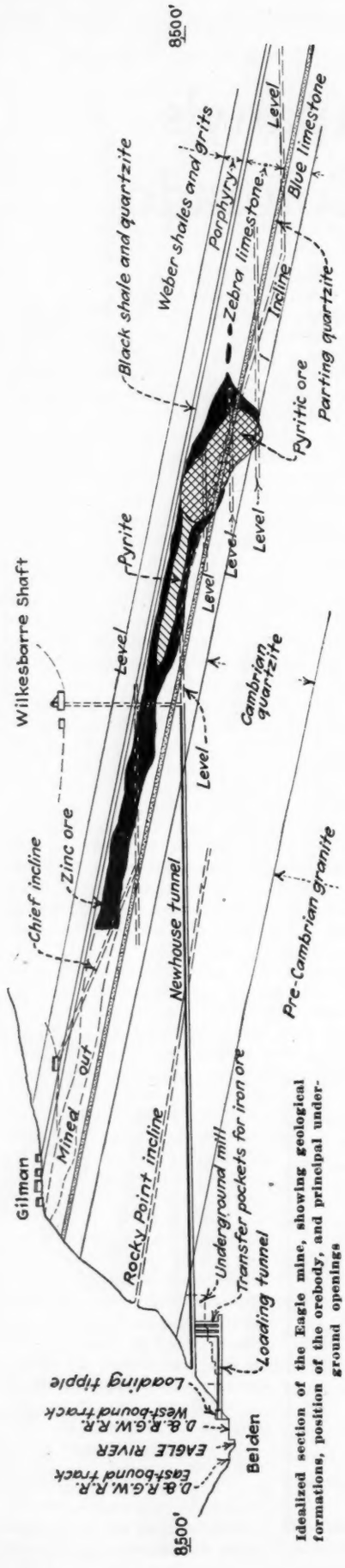
In 1880 the railroad reached Leadville, and in 1881 it had been extended through Eagle Canyon, below the town of Gilman. With the arrival of the railroad and the shipment of ores from the limestone mines came the discovery of the gold-silver ores in the quartzite formation, exposed in Eagle Canyon below the porphyry limestone horizon, on which the first ore discoveries were made. With the development of profitable mines in both the limestone and quartzite horizons during the period from 1880 to 1893 the camp expanded, but the panic of 1893 caused a suspension of practically all mining, little work being performed in the district during the following ten years. In the early period of activity the oxidized ores in both the limestone and quartzite formations were worked out. The lower mine workings in the limestone horizon exposed attractive faces of low-grade complex sulphides, pyrite, blende, and galena, but in the quartzite horizon the sulphide oreshoots were small, unprofitable lenses of pyrite.

The lead ores then produced from the limestone horizon were of the usual oxidized iron-lead variety, which carried substantial amounts of silver. In the quartzite horizon, the orebodies, though quite extensive over limited areas, did not possess the size or continuity of the limestone oreshoots. These quartzite ores consisted of seams of talc, masses of clay, and iron-stained quartzite, containing some gold and silver, and occurred in the fractures, seams, and bedding planes of the quartzite. The occasionally high gold and silver content compensated in some degree for their erratic distribution.



Production of zinc ore in the district began in 1905, and in 1906 The Eagle Mining & Milling Company acquired the Iron Mask mine, which was then the best-developed property on the mountain. This company further developed the sulphide orebodies in its property, erected a 150-ton mill in Eagle Canyon, and became a steady producer of zinc concentrate. Ore treatment comprised slightly roasting the sulphides, separation of the roasted magnetic pyrite from the less-magnetic blende and non-magnetic galena with Ball-Norton magnetic machines, and tabling the blende-galena material. Zinc and lead concentrates were shipped, the roasted iron product being sent to the dump.

The discovery of large bodies of oxidized zinc ore at Leadville in 1911 again attracted attention to the Battle Mountain district, and The Empire Zinc Company began examining idle and accessible properties there for this class of ore. Results were disappointing, but the examinations indicated that the district might be developed into a producer of sulphide ores by consolidating individual properties under one ownership. Beginning with the purchase of one small group of claims in 1912, the company has gradually acquired title to all of the important claims on Battle Mountain. The company's property now forms one compact group of claims that extend from Red Cliff over Battle Mountain, and covers an area about two miles long and one mile wide. Purchase of the Iron Mask group, The Eagle Mining & Milling Company property, was effected in 1915. During the War the mine and mill were operated continuously. An aggressive development plan was followed and additional property acquired. At the close of the War mining of zinc was suspended. During the period, however, a pyrite orebody was developed, which occurred as the center or core of a chimney of zinc ore. This pyrite carried a profitable amount of silver, and, although the production of zinc ore was suspended for a time, mining of the pyrite-silver ore was continued.



Idealized section of the Eagle mine, showing geological formations, position of the orebody, and principal underground openings

A complete section of the geological formations of the district is exposed in the walls of Eagle River Canyon and on the lower slopes of Battle Mountain. The column consists of a basement of Pre-Cambrian granite and metamorphics that are overlain, in order, by about 200 ft. of Cambrian quartzite; 130 ft. of Cambrian (?) interbedded quartzites, sandstone, shales, and some dolomite; 35 ft. of Ordovician quartzite (the parting quartzite of Leadville); 70 ft. of Devonian (?) dark-blue dolomite, locally called "Blue Limestone"; a 4- to 6-ft. quartzite bed, locally named the "Parting Quartzite"; and 125 ft. of Mississippian dolomite, called the "Zebra Limestone"—all capped by several thousand feet of Pennsylvanian shales, quartzites, and sandstones. A porphyry sill, averaging 60 ft. thick, is everywhere present at, or just above, the upper contact of the Zebra formation. The strata are conformable, striking northwest-southeast and dipping 11 deg. to the northeast. Faults are common throughout the mine, but the displacements are small, ranging from a few inches to 35 ft.

The ore-bearing solutions are believed to have risen through channels in the granitic basement, and thence traveled upward through the stratified formations, to deposit in horizons favorable to replacement. These solutions, in rising, were probably not evenly distributed along the fissures, but rather localized in places where ground preparation by fault intersection or otherwise had made especially favorable channel ways. The loci of the rising solutions are often mineralized in the dolomite formations, with resulting sulphide bodies of a funnel or inverted-cone shape. These are called "chimneys." The ore solutions left the chimney sources, in which they were rising steeply, to follow favorable beddings in the dolomite. The beddings were mineralized to make typical blanket or "manta" orebodies, or to form long cylindrical deposits of elliptical cross-section, with horizontal dimensions from 50 to 300 ft. and vertical dimensions from 8 to 50 ft. Normal trend of the blanket deposits is up-dip or southwest from the chimney sources.

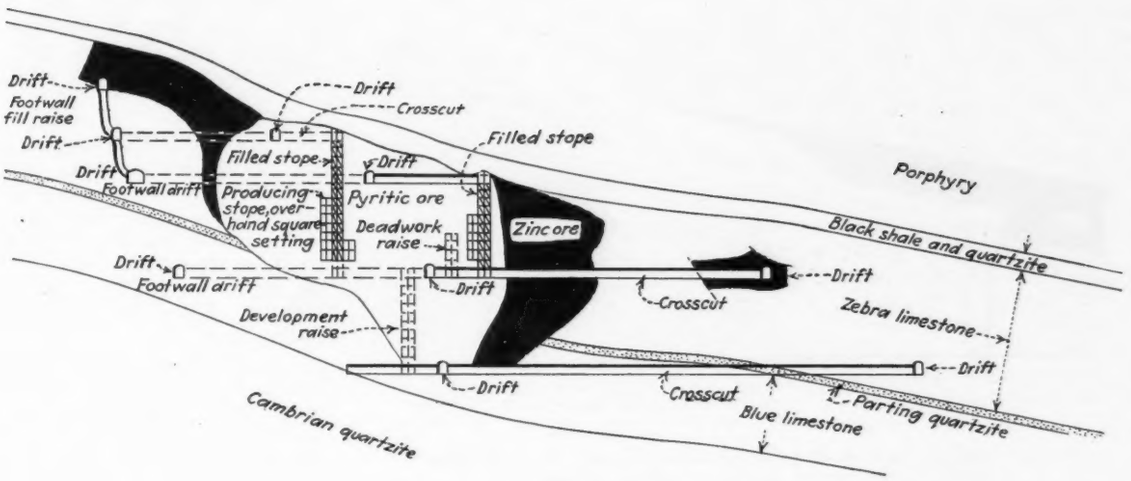
The most important ore-bearing horizon is the Zebra formation. This dolomite averages 125 ft. in thickness. At the top the formation is uneven and marked by what appear to be pot holes, which were filled with silt during a period of erosion. Recrystallization of the dolomite has produced a mottled effect of black and white crystals, or a peculiar striped pattern resembling zebra markings that give the formation its name. The recrystallization is widespread and extends beyond the known ore-bearing area. The upper Zebra contact has been most favorable for replacement, probably owing to the damming of solutions by the impervious capping. This capping overlies the chimney ores and most of the blanket ores. A few blanket and cylindrical orebodies are entirely within the Zebra formation and do not reach the capping.

A clean-cut contact between ore and waste is the rule. "Assay walls" are rare. The massive-sulphide ore is a mixture of pyrite, sphalerite, siderite, and galena. The cores of the chimneys are almost exclusively of pyrite, and this, in places, carries enough chalcopyrite and freibergite to be a copper-silver ore. Sphalerite and minor galena, intimately mixed with pyrite and siderite, surround the pyritic chimney cores. The blanket and cylindrical orebodies branch from this zinc-ore envelope and trend southwesterly, up-dip, toward the outcrop. The sphalerite is the iron-rich variety, marmatite, carrying about 53 per cent zinc. Pyrite and siderite are the gangue minerals. In general, the grade of the zinc-lead ore varies inversely with the amount of pyrite in the ore.

Ore rubbles are frequent in many of the sulphide orebodies. They consist of irregularly shaped ore fragments, with large voids between the boulders. The fragments are not cemented together and, except for occasional barite and siderite crystals, no crustification into the open spaces prevails. The origin of these rubbles is not definitely recognized. They appear to be the result of post-mineral faulting.

New orebodies, or downward extensions of known blanket ores, are sought largely in the Zebra Limestone horizon. The overlying cap rock is entered only to procure waste and to provide necessary openings for the distribution of filling to stopes. Formations underlying the Zebra are developed when Zebra Limestone ore drops below into the Blue Limestone. This occurs only in the feeding vents or chimneys; and rarely is the Blue Limestone mineralized without associated and more intense mineralization in the Zebra above it. Preference of ore for the Zebra Limestone, the thinness of this formation, and its essentially unbroken monoclinal structure make prospecting for blanket extensions and new blankets relatively simple.

Exploration headings are driven parallel to the strike along the Zebra formation. The depth of these headings below the cap rock has been increased in the last few years, in conformance with improvements in deep-hole hammer-drill operations. Formerly, they were carried a short distance under the cap, so that the heading itself would traverse the most favorable zone at the top of the Zebra formation. With the introduction of the deep drill and 75- to 100-ft. holes, the headings were driven about midway between the top and bottom of the Zebra formation, or 60 ft. under the cap. With further improvement in drilling to obtain 150- to 225-ft. holes, some exploratory drifts have been carried at the base of the



Section through chimney orebody showing relative positions of the zinc and pyritic ores

Zebra Limestone. The drill holes, which supplement a drift in an exploration program, are spaced at 50- or 100-ft. intervals, and are directed to the northeast, at angles of 40 to 45 deg. above the horizontal. The drill used is a Model 34 Turbo Gardner-Denver drifting unit. Diamond drilling is employed to only a comparatively limited extent, to test ground below the levels and to prospect deep chimney ores. In this work a Sullivan Turbinair diamond drill is operated under contract.

Usually, to develop blanket ore up-dip is more difficult than to find a section of ore by drilling and drifting along the strike. Several methods are used. A common one is to raise to the back through ore that has been discovered by drilling over a strike drift, then crosscut southwest through the blanket from hanging wall to footwall, again raise to the back of ore and crosscut to the footwall, and so on, until the "step-up" system of raises and crosscuts reaches a higher level. Another method is to drive a slope through the ore, handling the muck by scraping. This method has been used only to a maximum distance of 200 ft., and only where the orebody is relatively regular in outline. Unless the up-dip trend of the blanket or cylindrical orebody may be assumed with considerable assurance, to lose contact with the ore is undesirable. Development from lower exposures to ore higher up the dip is preferable to following the ore down. In some of the irregular orebodies lying under the cap rock the only satisfactory exploration method is that of actual stoping of the ore, aided by deep-hole drilling from the stopes. Such ore is developed practically as it is mined.

Development in the chimney orebodies, which have ore heights of 80 to 125 ft., is by drifting through the ore on the strike of the formation, and then crosscutting northeast and southwest, at 50-ft. intervals, until the waste walls are reached. Vertical raises develop the ore between levels.

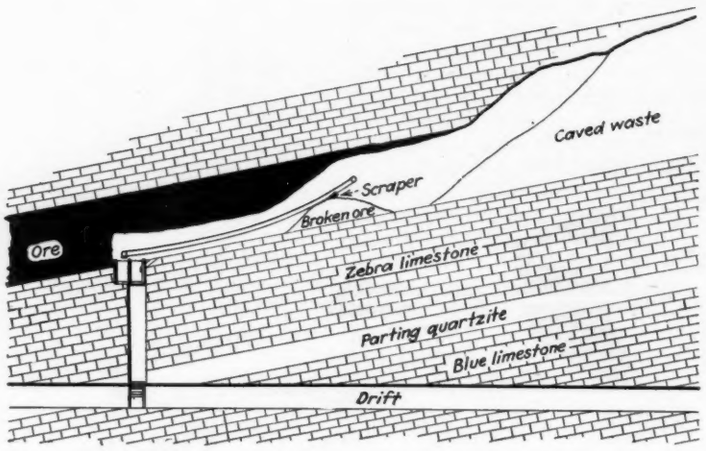
A 400-ft. shaft from the surface connects with the fourteenth and sixteenth levels. The sixteenth is 135 ft. above the river level in Eagle Canyon. The Newhouse tunnel connects the mine workings on the sixteenth level with the underground mill and with the surface at Belden. From the surface to the fourteenth and sixteenth levels are several inclines that are now used largely for ventilation. Mine development below the sixteenth level consists of two interior inclines, from which are turned off the seventeenth to twentieth levels inclusive. The vertical difference in elevation between these levels is 87 ft., and the distance between them, measured on the 15-deg. slope of the inclines, is about 330 ft. Excepting the twentieth, all the deeper levels connect to both inclines and, in other places, indirectly to the sixteenth level by a series of crosscuts and raises.

Most of the production is obtained from horizontal cut-and-fill stopes and from square-set stopes. In elliptically shaped cylindrical orebodies, which have a vertical height of 35 to 60 ft. and a horizontal length of 100 to 250 ft., the orebody is sectioned into transverse stopes and pillars. Stopes are 35 ft. wide and pillars 15 ft. The stopes are worked by normal cut-and-fill methods, from the base to the top of the ore. In some instances the ore is hand mucked to drawing chutes, but more often it is scraped. Filling from development or waste-caving stations is passed into the stope through raises from an overlying level, and is spread by scrapers. Filling may either closely follow the ore cut or be introduced subsequent to the removal of a complete 8-ft. slice, depending on the condition of the ore back.

A square-set aisle is carried on either side of the stope. This reduces the unsupported span, which only rarely may be as much as 35 ft.; partitions the waste from the pillar walls; and provides a tie for the 15-ft. stringers and trusses that comprise the timbering in pillar stoping. The ore is weak at the top of the orebody, and often the final cut in cut-and-fill stopes must be made with square-set timbering. Timber cribs are used for temporary support, when necessary, in the lower cuts. Stopes are filled to the top and cribbed tightly against the waste back. Although no actual shrinkage stoping is practiced, the basal ore is sometimes so mined for two or three cuts before being drawn. This is simply a double- or triple-cut system, and is practiced only in rare instances where an unsupported 35-ft. span is safe.

Pillar removal follows mining of the ore from the adjacent stopes. The procedure is to break the ore from one end of the pillar, drawing it through chutes in the square-set aisles, erected during the mining of the boundary stopes, and timbering across between these aisles with 10x10-in. 15-ft. stringers. Simple trusses and small cribs catch up the waste back above the pillar ore. Mining progresses longitudinally from one end of the pillar to the other. Usually, only that part of the pillar excavation lying under the filling crosscut is filled, the remainder of the stope being allowed to cave.

Open underhand stopes have been tried as substitutes for horizontal cut-and-fill stopes. As the waste-rock back and top ore are weak, the ore is extracted by breast stoping, a 15- to 20-ft. shell of ore being left overhead. The ore in the floor is milled into drawing raises, and the stope worked down to the bottom waste rock. When completed, the stope is 200 to 250 ft. long and about 40 ft. high. The width has been subject to experiment. A stope 20 ft. wide was successfully operated by this method. After removal of broken ore, the stope walls were gob fenced,



Cylindrical orebodies are mined by a retreating method, the back being caved and the broken ore moved with a scraper

the stope was filled, and the top ore shell taken off by cut-and-fill methods. Because of the low height of the ore, much of that broken must be mucked or scraped into the mill holes.

Application of the method to a stope 35 ft. wide has been unsuccessful, even with a well-gunited back. Much of the ore is too "short" for this span, and slabs break loose from partings to a depth of several feet above the gunited surface. The strength of the gunite is not sufficient to hold such slabs. Because of its limited applicability, underhand stoping has been abandoned for the horizontal cut-and-fill system. This latter system is safer because it provides an opportunity to support "short" ore on cribs, when necessary, and it is more economical, because with it a wider safe-stoping width is possible and the amount of ore left in pillars reduced.

Good results have also been obtained with a different type of open stoping that does not involve any support of the back. It is applied to cylindrical orebodies that have a regular ore-waste contact, elliptical cross-section with horizontal width not exceeding 60 ft. and a vertical height of 25 ft. or less. In this method the orebody is divided into 150-ft. lengths and an 8x12-ft. heading driven centrally along the base of the ore from one end of the section to the other. The ore is mined by overhand drilling and progressive "ring" blasting at the updip end of the section, whence it is scraped to a raise at the lower end. A thin shell of ore is left at the end of the stope being mined. This shell retards caving of the back until the cut has retreated far enough down-dip to prevent waste rock falling from the back and mixing with the broken ore. Although the shell is drilled close to the breaking face, it is not blasted down until the face has advanced a suitable distance from the exposed waste back; sometimes it can be recovered before the waste caves. The method works well with an orebody of the proper size and regularity and where the ore is relatively strong and the waste rock will remain in place long enough to permit scraping the ore out of the stope. As the joint occurrence of these conditions is not common, the method cannot be applied generally in the mine.

The blanket ore at the top of the Zebra Limestone and directly under the capping is usually irregular in outline, of variable height, "short" and weak, and covered by a heavy capping. This ore is mined with square-sets, except when leads extend out under the capping, in which instances stull and headboards are sometimes practicable. Much of this ore is developed as it is mined. A raise is put through to the top of the ore, and from this the ore is mined out, using square-set support. Usually, the ore is broken upward from the bottom, temporary timber slides being placed in the square-sets to direct the broken ore to the chute and reduce handling in the stope. Use of filling depends on the requirements of each stope, and no advance provision is made for handling waste. If the square-set support retards caving of the back so that the working faces are not endangered, no filling is provided. If filling is deemed necessary, it is obtained by driving a raise into the capping above the stope. These raises are branched out to form a Y, a short distance above the ore back. The faces in the Y's are then drilled with long holes, which are loaded heavily and fired simultaneously. Enough waste is brought down to fill the void left by the extracted ore. When the ore is short and sandy, it is worked down from the top by underhand square-setting. This method has been applied to some ore that is practically unconsolidated sand, only picking being required to make room for the sets.

In more extensive blanket orebodies, where the ore limits can be roughly determined by deep-hole drilling, stopes are laid out in checkerboard fashion. Individual stopes range from three by five to four by six sets in floor area, and from three to six sets in height, each stope thus constituting a rectangular plug through the blanket. These stopes are mined by square-setting and filled from the back, as already described. They are worked in such sequence that about one out of three lies within waste packs of formerly worked-out blocks. These stopes, which may be considered pillars, are removed in the normal manner, often by underhand square-setting, because of crushing of the ore and cut side walls. The back is allowed to take weight and finally caves.

The pyritic ore of the chimney orebodies is too heavy and weak to stand unsupported over more than ten or twelve feet, and usually it is so poorly cemented that timber sets must be placed as soon as room is available for them. In some places the pyrite is in the form of unconsolidated sand, and underhand mining is the only method practicable. Caving methods are not feasible, because with them the grade of the ore mined cannot be controlled. Top-slicing, which mechanically is well suited to mining much of the ore, is not used, because of the high sulphur content of the ore and the consequent possibility of self-ignition in the mat. In the best-mineralized areas the ore is 100 to 135 ft. thick. Stopes are carried two sets wide and from five to ten sets long, in floor plan, and from the base to the top of the ore.

A two-set raise through the ore is the initial step in stope preparation. This raise connects with a filling transfer level above and with an extraction crosscut below. One compartment is used for an ore chute and waste pass and the other for a manway, pipe lines, and materials. Overhand square-set stopes are started at the base of the ore or on the second set above the drawing level, where the base of the ore drops below this level. If the ore back is sufficiently strong, as many as five tiers of sets will be placed before filling is introduced, and much of the ore will be broken onto slides to direct it to the chute. In weaker ground no more than two tiers are kept open. The stope is filled to within one set of the back, and a one-set cut is then made, after which the stope is again filled to the base of the upper sets.

As the stopes are small, filling and breaking are not carried on simultaneously but in rotation. Stopes are lagged both inside and outside of the sets, the inside lagging retaining the fill. Broken ore is used to fill the space between the outside lagging and the standing wall, thus preventing spalling of the ore wall and loosening of the blocking. The outside lagging and this broken ore pack are recovered in mining the adjacent stope. Much of the orebody is so loose that it must be worked down from the top, underhand square-setting being employed in small

rectangular blocks. Normally, several tiers of sets are placed before waste filling is introduced. Occasionally, however, the stope is filled after each slice. As underhand or overhand stopes are completed, the raise is extended, to the depth of two sets, into the ore that is to be mined next. This extension or "wing" forms the extraction raise for the new stope adjacent to that worked out. The original two-set raise of the completed stope is filled with waste and abandoned.

Waste for filling iron-ore stopes comes from development and general caving stations. Caving from the back above stopes is not practiced in the chimney areas. The general caving stations are placed in the porphyry and shale of the capping. Where the capping is good caving ground, a two-compartment vertical raise is driven 25 ft. above the drawing level. A 50-deg. inclined raise is then driven from the vertical raise into the capping and branched, and short drifts are turned off. The ground is cone drilled with jointed-rod drills, and the holes are heavily loaded and blasted simultaneously. In good caving ground this is sufficient to start the caving. Where the capping is firmer, the back has to be undercut for a width of 60 to 80 ft. by shrinkage stoping before the desired self-caving will start.

Average unit costs of development raises, drifts, and crosscuts for a recent twelve months' period are presented herewith. These costs apply to a total of 366 ft. of raises and 3,460 ft. of drifts and crosscuts, 822 ft. of which was timbered. Most of the raises were 6x11 ft. in cross-section, square-set timbered, and completely lagged. The sizes of the various drifts and crosscuts ranged from a minimum of 6x7 ft. to a maximum of 8x8 ft.

Table I—Average Unit Costs of Raises, Drifts, and Crosscuts

		Cost Per Foot
Drilling, labor		$1.83
Drilling, explosives		2.15
Timbering, labor	(a)	1.03
Timbering, supplies	(a)	1.62
Mucking, labor		2.83
Air and water lines, labor and supplies		0.76
Track, labor and supplies		0.51
Breaking, distributable	(b)	1.90
Handling	(c)	3.50
General mining, undistributable	(d)	1.71
Engineers and geologist	(e)	0.31
Total		$18.15

(a) Cost per foot distributed over total footage. (b) Includes part of wages to shift bosses, nippers, powdermen; part of cost of general mine tools, such as shovels, picks, and saws; part of cost of carbide, steel sharpening, drill maintenance, and compressor operation. (c) Covers handling of waste or broken ore to its destination. Includes part of expense of operating 1½-ton motor, part of the tramming costs, and part of the operation costs of the deep-level inclines, 16-level motor haulage, and hoisting at No. 1 shaft. (d) Includes part of wages to mine foreman and assistants, engineering department, and mine watchmen; part of costs of oils and greases, general mine maintenance, sampling, ventilation, pumping. (e) $100 per month is charged direct to development headings for surveying and geological work, in addition to part of the engineering and geological department expenses.

Stope production statistics, as well as those for timber and powder consumption in stoping operations, follow:

Table II—Production, Timber, and Powder Statistics for Stoping Operations

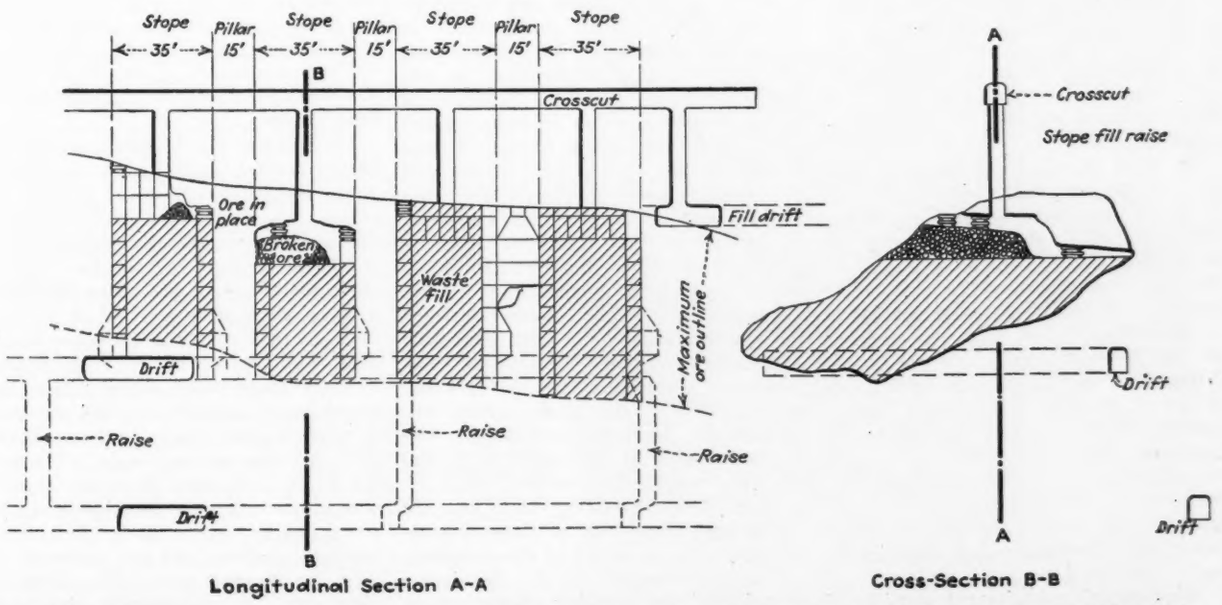
	A	B	C	D
Tons per machineman shift	25.7	28.4	27.5	21.7
Tons per timberman shift	13.5	21.4	41.7	18.4
Tons per mucker shift	13.5	19.5	24.0	19.3
Tons per fill-labor shift	35.1	44.2	....	....
Tons per total man-shift	4.64	6.4	9.1	6.4
Timber, board feet per ton	13.9	7.3	3.5	6.7
Powder, pounds per ton	0.67	0.53	0.38	0.41

A Average for eleven zinc square-set stopes. Powder per ton includes that used in breaking waste from the back for filling. Mucking and filling by hand. *B* Average for nine zinc cut-and-fill stopes. Figures include square setting of tops of stopes, in addition to normal cut-and-fill operations. Mucking and filling in stopes largely by scraping. *C* One open stope of the low-dip type, in which back caving is allowed. The stope is not filled, and timbering is largely temporary crib supports. *D* 15-ft. underhand pillar stopes with truss and stringer support. Figures are based on two stopes. Tonnage involved is insufficient to give accurate data, and filling, as yet, has not been done. Mucking is by hand. Most of the ore slides direct to chutes.

Ventilation of the mine is by natural draft. The normal course is in at No. 1 shaft, in the northwest end of the mine, and out at No. 2 incline, in the southeast section. Normal intakes are No. 1 shaft, the Chief incline, Rocky Point incline, and Newhouse tunnel. Normal exhausts are No. 2 or Black Iron incline and No. 3 or Belden incline. The volume of air and, occasionally, the direction of movement undergo seasonal changes, the volume varying from 16,000 to 25,000 cu.ft. per minute. Of this amount only 6,000 to 8,000 cu.ft. traverses the deep-level circuit, below the sixteenth level. This part of the air will pass down the 16-E incline and ascend through stopes and the 16-23 incline to the sixteenth level, whence it moves southeast and exhausts through the No. 2 orebody workings.

Auxiliary ventilation to places not reached by the natural draft is obtained with small Coppus and Buffalo blowers. Galvanized-iron air piping is used. Dry-bulb temperature on the surface at the intakes ranges from 75 deg. F. to 20 deg. below zero. Irrespective of outside temperature, the dry-bulb temperature of the air is about 57 deg. F. after it has traveled 1,500 ft. along the sixteenth level from No. 1 shaft toward the 16-E incline. This may be considered the average rock temperature in the upper workings. In its passage through the iron-ore country below the sixteenth level, the temperature of the air rises to 78 to 83 deg. F. and it becomes practically saturated. This heating is caused by slow oxidation of pyritic ore and of timber, and by mining operations. Available data on rock temperatures are scanty, but those that have been obtained indicate a rise of about 2 deg. F. with each 100 ft. of increased depth below the sixteenth level.

The natural draft is controlled to



Most of the production is obtained by cut-and-fill methods that employ alternate stopes and pillars, as shown in this sketch

Hoisting station at the top of 16-23 incline, on the sixteenth level

some extent by doors near the intakes, which can be kept shut in periods of low outside temperature. To prevent freezing in such periods, the natural draft through No. 1 shaft is choked. At the portal of the Belden incline, one of the natural exhausts, is a fan that will pull about 17,000 cu.ft. per minute through the incline. This fan, which is not in use now, was installed in 1923, when the mine workings were much less extensive. It is kept in operating condition for emergencies.

In general, air conditions above the sixteenth level are comfortable, and those in the most active area below this level uncomfortable, because of the partly vitiated air, high humidity, and temperature, which is just under 80 deg. F. To better these conditions, installation of a fan on the sixteenth level is planned. The fan is to deliver 60,000 cu.ft. of air per minute against a pressure of about 6.0 in. water gage and will have a maximum capacity of 90,000 cu.ft.

All drilling is wet. The greater part of the ore is broken with jackhammers, which are used in flat-back cut-and-fill stopes in preference to stopers, as the flat holes provide a better back and give better results generally than drifters in the readily drilled ore. Drilling equipment comprises No. 7 Gardner-Denver drifters, with 1¼-in. round hollow steel; No. 93 Gardner-Denver jackhammers, with ⅞-in. hexagon hollow steel; S-49 Ingersoll-Rand stopers, with ⅞-in. hexagon hollow steel.

For stope blasting in which fractions of sticks are not used, 45 per cent No. 2 du Pont Gelex dynamite is employed. Special ammonia du Pont dynamite, 40 per cent strength, is used for blockholing and other purposes where sticks must be cut and trickling of powder is to be avoided. For hard-rock drifting 40 and 60 per cent du Pont gelatin dynamite is employed, and for drifting in softer ground 45 per cent No. 2 Gelex. Blasting is with No. 6 Western caps and Black Monarch fuse, except occasionally in wet development headings when electric firing and delay igniters are used. In driving high raises and in waste-caving, electric firing is employed.

Mine pumping equipment consists of two American Well Works centrifugal pumps, connected in series and each rated at 650 g.p.m. under a 275-ft. head, and two Krogh centrifugal units in series, each rated at 500 g.p.m. under a 200-ft. head. These two sets of pumps, operated alternately, are driven with constant-speed motors and throttled with gate valves. Water is pumped from the twentieth level sump to the sixteenth level through a 1,250-ft. 6-in. line under a static head of about 350 ft. The line discharges into a ditch on the sixteenth level, which carries the water to the Newhouse tunnel and thence into the mill tailing line. About 400 g.p.m. is pumped at present, but the flow has varied from 250 to 600 g.p.m. in the last year. Gradual drainage tends to cause a decrease in flow, and lately deep diamond-drill holes have resulted in an increase. Water *per se* has never been a serious problem at the property, 700 or 800 g.p.m. being the maximum encountered in new headings or incline sinking operations. Such flows have continued only a few days at most. Pumping troubles have come from the sand and silt that accompany these surges of water and cut out the pump liners.

Ore from below the sixteenth level is drawn from stope chutes into 20-cu.ft. dump cars. These are hauled by 1½-ton storage-battery locomotives to either one of the interior inclines, and hoisted in trips of three cars up the inclines. On the sixteenth level the ore cars are gathered by 5½-ton storage-battery locomotives and hauled in trips of twenty cars to the head of the mill or to the iron-ore pockets. The cars are dumped by hand. Zinc ore from stopes above the sixteenth level is drawn from chutes into 50-cu.ft. gable-bottom cars, with a capacity of 4 tons. Trips of ten cars are hauled between the mill pocket and the mine chutes by 5½-ton storage-battery locomotives. The motormen and helper load the cars and empty them. Five motor crews are used on this sixteenth-level haulage, two each on day shift and night shift, and one crew on the "graveyard" shift.

Mine cars containing iron ore are emptied into any one of three storage pockets. The grizzlies of these pockets are at the elevation of the Newhouse tunnel, and the drawing chutes are at that of the loading tunnel, which is 88 ft. below the Newhouse tunnel. Iron ore is drawn from the pockets into a 13-ton gable-bottom larry car, hauled by a 5½-ton storage-battery locomotive. The larry car discharges from a tipple above the tracks directly into standard-gage railroad cars.

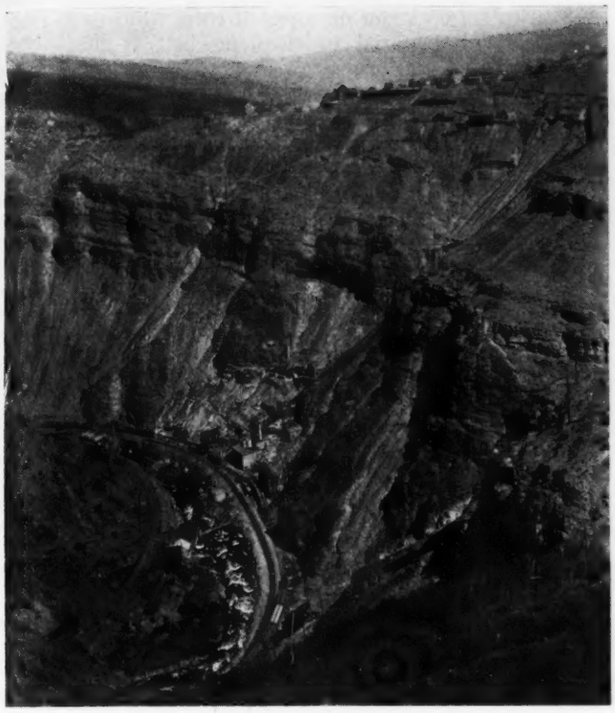
The capacity of the mill pocket is 2,000 tons and that of each of the three iron-ore pockets is 500 tons. Three ore passes between the fourteenth and sixteenth levels have a combined capacity of 5,000 tons. These, however, are used to but a limited extent as ore passes, because only a small amount of ore is being mined above the fourteenth level. They are kept full of broken ore and thus provide an emergency reserve. Additional storage capacity is obtained from the large number of stope raises, with individual capacities ranging from 50 to 300 tons.

A 24-in. track gage is used underground, except in a few stopes and in narrow crosscuts, through which filling is transported, where the gage is 18-in. Rails on the main haulage level and interior inclines are 30 lb. Those on the 1½-ton-motor haulage and hand-tramming lines are 16 lb. Curves on the motor haulage normally have a 35-ft. radius, with some a 60-ft. and one a 125-ft. radius. Where ground conditions will permit, new curves are put in on a 35-ft. radius. In heavy ground, curves with a radius as short as 20 ft. are used.

On the sixteenth-level haulage 50-cu.ft. Sanford-Day gable-bottom dump cars are used. The average load is 4 tons of zinc ore and 4.75 tons of iron ore. Below the sixteenth level and on intermediate levels, 20-cu.ft. Universal dump cars made by the Card Iron Works are used. These have a capacity of 1.4 tons of zinc ore and 1.65 tons of iron ore. With the 20-cu.ft. cars on the deep-level haulage lines, three 1½-ton Atlas storage-battery locomotives are used, and on the sixteenth-level main haulage, in the loading tunnel, and on the fourteenth level, four 5½-ton Baldwin-Westinghouse storage-battery locomotives.

The hoist at No. 1 shaft, used for men and materials and for transferring waste from development to zinc-ore stopes, is a double-drum unit, made by the Vulcan Iron Works and driven by a 100-hp. motor. At the head of the 16-16 incline is a single-drum hoist with a 52-hp. driving motor, and at the head of 16-23 incline a Stearns-Roger single-drum unit, driven by a 100-hp. motor.

No. 1 shaft, 260 ft. deep to the fourteenth level and 410 ft. to the sixteenth, is cribbed from top to bottom. Cross-sectional dimensions, inside of timbers, are 13 ft. 3 in. by 5 ft. 6 in. It comprises two adjacent hoisting compartments, each 4 ft. 8 in. by 5 ft. 6 in., inside of timbers, and one manway and pipe-line compartment. The 16-16 incline serves the seventeenth, eighteenth, and nineteenth levels. Where timbered,



Beldon, in Eagle River Canyon, and Gilman, on the slope of Battle Mountain

10x10 in. creosoted sets are used. Dimensions inside of timbers are 7x7 ft. The incline is on a 15-deg. slope, and the track consists of 30-lb. rails. The 16-23 incline, which serves the seventeenth to twentieth levels inclusive, is also on a 15-deg. slope, and where timbered, 10x10-in. creosoted sets are likewise used, inside dimensions being 7x7 ft. Here, also, the track consists of 30-lb. rail. On both inclines the curves into level stations have 35-ft. horizontal and 60-ft. vertical radii.

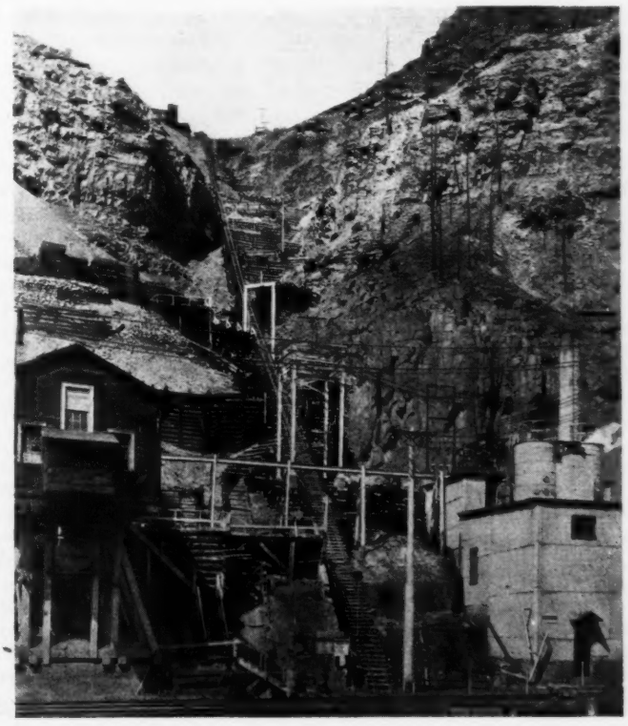
Timber purchased locally is delivered by truck to the collar of No. 1 shaft, where it is lowered underground and transported on timber trucks to its destination. Timber not purchased locally arrives on railroad cars at Belden. It is hoisted up the surface tramway to a timber yard at the portal of the Newhouse tunnel, whence it is taken into the mine on timber trucks pulled by the storage-battery locomotives.

Waste from barren headings, if the heading is below the sixteenth level, is hoisted through the inclines in 20-cu.ft. cars, and then hauled by locomotives to No. 1 shaft, where it is hoisted to the fourteenth level and disposed of in zinc-ore stopes. Some of this waste is used in iron-ore stopes on the seventeenth level. Waste from caving stations at the end of the 16-1 drift is drawn into 50-cu.ft. cars and discharged into the general waste-filling pass, which is in the footwall of the iron-ore stopes, between the sixteenth, sixteenth and a half, and seventeenth levels. Waste from the caving station above the fourteenth level is drawn into the same type of car and discharged into filling raises that serve near-by stopes.

Scraper hoists employed comprise: three 6½-hp. Sullivan HDA-2 air hoists; one 7½-hp. Sullivan HDE-7 BB electric hoist; one 15-hp. Gardner-Denver EL-2 electric hoist; and three 20-hp. Lake Shore Engine Works electric hoists. This equipment is used principally in the cut-and-fill and open stopes to scrape ore and spread waste filling. The small 6½-hp. air units are worked in square-set stopes when they can be spared from use in the cut-and-fill stopes. Each scraper hoist is operated by one man, who, in addition, places the tail block and bulldozes large boulders. Hoe-type scrapers of two sizes are used: one with a blade 32 in. wide, which can be used in square-set aisles, and a larger one with a blade 38 in. wide. Both stellited-boiler-plate and manganese-steel cutting lips have been used, but the use of the former did not prove to be economical. Power for the scraper hoists, at 440 volts, is carried into the stopes through three-conductor rubber-covered cable.

The compressor house is at Belden, along the Eagle River. Three compressors are operated. Two are Ingersoll-Rand units, with 100-hp. G. E. driving motors. One of these two units has a capacity of 1,275 cu.ft. of air per minute at sea level, and the other a capacity of 1,000 cu.ft. Both are so installed that they can be driven by two Pelton tangential waterwheels that develop 175 hp. at 580 r.p.m. when operated under an effective head of 500 ft. In the summer, when the water supply is plentiful, the motors are disconnected and the Pelton waterwheels employed. The third unit is a Chicago Pneumatic compressor with a capacity of 2,200 cu.ft. of air per minute at sea level, driven by a 390-hp. G. E. synchronous motor used for power-factor correction.

The two larger units provide sufficient compressed air for mine use. In the summer, however, all three can be operated with economy, the cut-out of the largest unit being set a little lower than that of the others so that it will idle part of the time. Each compressor has a separate receiver that discharges to a common 8-in. line. This line passes under the railroad tracks to the Newhouse tunnel, where it changes to 6 in. in diameter. Four receivers in the mine take care of surges.



Incline tram in Iron Mask Gulch. Tunnel portals at left and substation No. 4 at right.

MINE COSTS

Morris J. Elsing

UNIT COSTS of mining show close similarity all over the United States, although there are many exceptions. This prompts a question as to why unit costs should be similar and this, in turn, brings up for consideration the elements or factors which control mine costs. That the cost of doing the same thing under the same conditions should be the same is axiomatic. Variations in costs, therefore, are due to variations in working conditions, and a proper analysis should show a relationship between the two.

The conditions which control and finally determine unit mine costs are many. The most important of them are outlined in the following under four main headings.

Cost Variables

I. Underground conditions.
   1. Ground conditions or character of the rock
   2. Amount of water
   3. Rock temperatures
   4. Natural or artificial ventilation
   5. Whether operating through shaft or tunnel
   6. Depth underground
   7. Length of tram

II. Location of property
   1. Cost of supplies
   2. Cost of power
   3. Cost of transportation
   4. Wage scale
   5. Efficiency of labor

III. Efficiency of labor
   1. Wage scale
   2. Lack or abundance of labor
   3. Climatic conditions
   4. Effect of winter or summer
   5. Periods of prosperity and depression

IV. Efficiency of management
   1. Esprit de corps
   2. Methods
   3. Speed of work or scale of operation
   4. Tools and equipment
   5. Ventilation, sanitation, and safety
   6. Economic policies
   7. Many miscellaneous factors

Underground Conditions—Conditions met underground are exceedingly important in determining costs. Ground conditions are the most important of these. By ground conditions is meant the character of the rock formations as to hardness and their standing characteristics when openings are made, the size and shape of orebodies, the width of veins and their inclination, the character and homogeneity of the ore, the topographic features over the orebody, as affecting drainage, for instance; and other physical characteristics. These chiefly determine the mining method to be used, and the mining method determines to a great degree the resulting costs.

The amount of water to be handled, rock temperatures, natural or artificial ventilation, shaft or tunnel work, depth underground and length of tram also have their effect on costs.

In some operations the cost per ton for prospect and development work is one of the largest items which make up the total cost of mining. This cost is determined by the characteristics of the orebody, the tonnage in sight, and the economic policy of the management.

Location of Property—Location is an important factor. Generally speaking, isolation raises the cost of supplies, power, and transportation. Often it necessitates higher wages and causes a decrease in the efficiency of labor. At exceptional isolated properties cheapness of timber and water power may compensate for the high cost of supplies. Isolation, however, is usually unfavorable to low costs.

Efficiency of Labor—The efficiency of labor is determined chiefly by the wage scale, and the lack or abundance of labor. Climatic conditions and altitude are important factors. At some mines the output per man in summer and in winter will differ, inasmuch as the summer heat added to the mine heat makes working conditions less favorable. Periods of prosperity and depression are reflected in the costs. In the latter periods additional effort upon the part of the workmen is stimulated not only by an abundance of labor but also by the keener desire to assist in lowering costs to make possible a continuation of production in the face of lower metal prices.

Efficiency of Management — Under this heading are grouped all those items which are determined by the management. These include the selection of the proper methods, tools, and equipment. Excessive speeds in development work and forced production from a mine always decrease efficiency and increase costs and are not warranted except under special conditions, such as a high metal market. The management is responsible for the esprit de corps which is so essential in obtaining best results. Upon final analysis, good management is the most important single factor in the business of mining.

The efficiency of labor is not nearly as important an element in the ultimate cost as is generally believed. We usually get what we pay for, be it motor cars, labor, or diamonds. "Cheap" labor does not exist in the United States. Shaft sinking wages vary from $5 to $9 per shift, but with the latter wage sufficiently more work is done to make up the difference over the $5 rate, and the resulting cost will be more or less the same. Contract and bonus systems are tending to equalize the cost per unit of work all over the country. The present tendency is to buy units of work rather than the time of the workman, and prices are constantly becoming more uniform. The cost per ton of hand shoveling is proof of this. With colored labor in the South, with Mexican labor in the West, and white labor in the Midwest lead-zinc districts, the wages vary considerably, and the output in tons per shift varies still more, but the cost per ton is closely the same. Variation in costs of shoveling can be explained by such local conditions as ventilation, length of tram, amount of sorting, and other working conditions.

SUMMARIZING, I believe that, in general with equal ground conditions and equal efficiency of management, unit costs will be more or less the same all over the United Sates. I do not believe that what I have said regarding labor in the United States applies to the world at large. In certain parts of the world where labor is cheap it is not efficient in point of output but very efficient in point of cost per unit of work. Take, for example, the Bawdwin Mine,[1] in Burma, India. There, the average output per shift of shovelers in stopes in 1921 was 4.6 tons, costing 8.6c. per ton, whereas in the United States the output with negro labor at Mascot, Tenn., in 1925 was 16.8 tons, at a contract price of 13.5c. per ton. The shovelers' output in the Wisconsin zinc district is 24 tons per shift at a contract price of 14.5c. per ton and a total price of 19c. per ton. At the Bawdwin Mine, 17.4 miner shifts and 6.6 mucker shifts, a total of 24 shifts, are required to mine, muck, and timber one square-set in a square-set stope; whereas in the United States the same amount of work is done in two or three shifts. Yet the labor cost per ton of ore produced at Bawdwin from square-set stopes is only about one-third as much as in the United States and the total cost of mining is much lower than the average cost of stoping in this country. To a certain extent mechanical appliances in United States mines offset this advantage of cheap labor, but in some parts of the

[1]Transactions, A.I.M.E., Vol. 69.

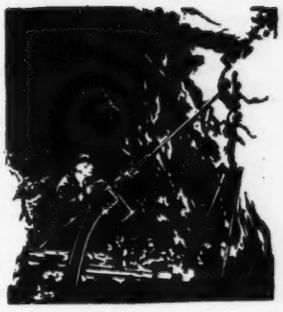
world cheap labor is undoubtedly a very great advantage.

The cost of production of almost anything has a tendency to become equal the world over. However, this tendency of equalization can be and is being retarded by economic restrictions. One such restriction is a tariff. A high tariff unquestionably adds to the cost of mine supplies and consequently increases the cost per ton. The restriction of immigration helps to maintain high wages in the United States, and still other restrictions have a direct bearing on the costs of mine operations in the United States. I am attempting to make no other point than that in the United States the cost of doing similar things under similar conditions should be more or less the same, and, further, that this does not apply to the rest of the world, largely because of economic restrictions which affect costs.

SIMILARITY of costs applies only to the unit cost of mucking per ton, drilling per foot, drifting, raising, or shaft sinking per foot or the cost of breaking ground in the same kind of stopes. To be specific, the cost of drifting in hard limestone should be practically the same in Arizona as in New York, provided the same methods are used. The use of mechanical mucking machines reduces the direct cost of mucking, but if all depreciation and amortization charges of machines, which are rapidly being improved and replaced by more efficient machinery, are added, the costs of drifting in the localities mentioned are not necessarily the same, because the efficiency of management plays an important part.

Use of the wrong type and size of drilling machine will seriously affect the amount of drilling per shift and the cost per foot. Worn out, obsolete drilling equipment will do more to retard the progress of drifting, and thereby raise the cost, than any other single item, and if such equipment is used, costs cannot be comparable. The point is this — there is some cost per foot of drifting in hard limestone which can be taken as a model or goal which one may strive to attain. In other words, there is a minimum cost for drifting under the present conditions of operation which one may reasonably hope to get.

TOTAL costs of mining are usually not comparable except where work is done under exactly similar conditions. For example, no grounds for comparison between mining in square-set stopes and quarries are available, but one may compare mining in two quarries or in two square-set stopes. These comparisons, however, are limited to unit operations, as the total cost may vary greatly, owing to local ground conditions, such as overburden, in the case of quarries, and the amount of waste to be sorted, in the square-set stopes. In square-set mines, the total cost of mining will depend largely on the cost of development work



per ton of ore mined. The board feet of stope timber per ton in those mines should be essentially the same, and the cost of placing that timber and breaking the ore will likewise be similar, provided ground conditions are equal. With 8x8-in. timbers, for example, a square-set contains a certain number of board feet, and from this set a certain number of tons of ore will be produced. Making allowances for blocking, lagging, flooring, wedges, and breakage, one may obtain an accurate figure which will represent the average amount of timber required per ton of ore. Such a figure might be called "par" for square-set stopes with 8x8-in. timber. Likewise, a top-slice stope and any other kind of a stope may be considered as having its "par" for timber. In the same way, a timbered drift, a square-set raise, a cribbed raise and a shaft have their timber "pars." Similarly, there are labor "pars" for mucking and tramming and also for breaking different kinds of ground.

My purpose in this series of articles is to show what these "pars" can be under given conditions and to compare them with actual costs that are being obtained, and also to compare costs of mining all over the United States. Such a task is exceedingly difficult because most cost statements are not made up similarly and are, therefore, not directly comparable.

As to the accuracy of mine costs, the total direct cost of mining per ton of ore is easy to determine. Any system of cost keeping shows at the end of the month the tonnage produced and the money expended in its production. The latter divided by the former gives an exact cost per ton. However, when it comes to the costs per ton of development work, stoping, and other operations and the details of these individual operations, accuracy ceases.

The supervising personnel of every well-regulated mine is anxious to obtain good mine costs. Sad to say, accuracy is not always considered one of the essentials of good costs.

In general, mine costs can be divided into two main classes—costs over which the foremen and shift bosses have little or no control and costs for which they are directly responsible. In the first classification come prospect and development costs. Cost per ton of this work is fixed largely by the management. It may be decided that 10c. per ton or $1 per ton is the amount that is to be expended for the search for new ore. In either event this cost is predetermined and depends upon the policy of the management and is governed by ore, conditions, the price of the metals mined, and the general financial status of the company. Foreman and shift bosses like to show low costs per foot of development work, but they are more anxious to show good stoping costs.

DEAD work and repairs is another item for which the bosses are not directly responsible. If a station, drift, or shaft needs retimbering, the work must be done more or less regardless of cost. Pumping, hoisting, transportation, ventilation, and extraordinary development work are not items with which the shift boss is vitally concerned. These things, of course, are under his supervision, but he feels that he is in no way responsible for the cost per ton for pumping water. The basis upon which his work is judged and compared is the cost per ton of stoping. Therefore, consciously or unconsciously, he favors this cost at the expense of these other costs over which he has no control and for which he is only indirectly responsible. The favoritism can be shown in numerous ways. Whereas in some mines timekeepers go underground and actually tally and record the men working at their different places, in others the shift boss makes the underground segregation of labor, which he delivers to the timekeeper, who figures monthly costs from the information thus obtained. Even where the timekeeper goes underground, he is likely to be much influenced by suggestions of the shift boss as to how certain labor shall be charged. Usually he sees the men underground only once and naturally misses those who may be getting supplies, tools, or powder. For this reason, he must depend upon the shift boss for his final report of the segregation of labor. That the shift boss or the jigger boss under him favors the costs for which he is held most directly responsible is only natural and human. As an illustration, the time of a man working a half shift on repair work and a half shift in a stope will generally be charged as a whole shift to repair work. In such little ways the stope will always get the advantage, and these small but continuous credits will during a month's time combine to make an appreciable amount.

Timber, tools, powder fuse, and caps are issued and charged to various classes of work by requisition from the shift or jigger boss. If any "left-overs" accumulate they will usually find their way without charge to the particular piece of

work being favored by the boss, and this, as already stated, is usually his stope.

A certain competitive spirit is likely to prevail between different mines of the same company, different sections of the same mine, and different bosses in the same section, which actuates these propensities. For the same reason, most ore is drawn from the chute that runs most easily. Given two drifts, one in hard ground and one in soft, the one in soft ground will probably be pushed at the expense of the other, because the monthly footage driven is thereby increased and costs per foot are reduced.

Competition between night and day shift is not nearly so keen as it was twenty years ago. In those days, in many instances, to show his own superior skill, the day or night shift boss commonly hampered the boss on the opposite shift in every way possible, especially if they were at all unfriendly. This was done in many ways. One of the men would muck all the fine ore and leave the boulders to be broken by the other shift. He might leave timbering to be done by the latter. If a broken timber or large boulder clogged the mouth of a chute, he would draw from another chute, instead of removing it. He might even leave insufficient broken ore. This kind of competition is not desirable, as it raises costs. Closer supervision, which provides greater cooperation between the two shifts, has largely eliminated it.

I do not mean to imply actual dishonesty in segregating costs. The point I wish to make is that the intense interest in keeping down costs manifests itself not only in more efficient operations but in a certain amount of somewhat incorrect bookkeeping as well, which is cause for inaccuracies in unit costs.

USUALLY the simpler the cost system is, the greater its value. If left entirely to the cost department, a complicated system sometimes results. Whatever costs are kept, they should be the result of close cooperation between the cost department and the operating department. Costs are sometimes recorded which do not mean a thing, and in no sense are they comparable from month to month in the same mine nor between different mines in the same camp, nor betwen different camps. In this class are such items as the "total pounds of powder per ton" and the "board feet of timber per ton." The first item depends largely upon the number of feet of development driven during the month and the character of the ground. The amount of drifting done each month varies and the tonnage of ore remains more or less constant. One ton broken in a drift requires from seven to twenty times as much powder as a ton broken in a stope. Obviously, the only figure of value is the amount of powder per foot of drift, raise, or shaft, and the amount of powder per ton of ore in stoping. Exactly the same reasoning applies to the timber used. Some companies make a practice of reporting the cost per foot of all development work. Development work consists of drifts, raises, winzes, and shafts. The cost of each of these operations varies greatly and an approximate ratio of their cost might be set down as 1, 1.5, 1.8, and 6 in the order named. Now, to lump the cost of this work and figure an average cost per foot for breaking, timbering, mucking, and a dozen other items for the total footage driven per month is almost ridiculous.

Theoretically, a square-set stope requires an exact number of board feet per ton of ore mined. If the cost sheet shows the number of board feet used in such a stope, one has a figure of value because if the timber greatly exceeds the theoretical amount, an investigation should be made. The cost system then proves of real value.

METHODS OF SEGREGATION vary. Different companies have different methods of making charges. For example, charges for compressed air, rails, and other supplies may be considered. A compressed-air account is kept, and to it are charged the cost of compressing air, of pipes and pipe lines, of repair and replacements, and other allied charges. A record of the drill shifts worked during the month is kept and a rough distribution is made between development and stoping drills. Although this is perhaps as good a method as is possible, it is far from being accurate. In the first place, the stope is being charged with an undue proportion of line run out in a prospect drift. On the other hand, the drift is charged with much too large a proportion of the compressed air produced. Close records kept of drilling operations show a drill actually runs only 40 to 90 min. of the eight-hour shift. In other words, the compressed air passing through the drills comprises only 10 to 15 per cent of the total air produced. The rest escapes in leaks and is used in "blowing" air for ventilation. During the last 20 or 30 min. of the shift the men in stopes and drifts, wherever blasting has been done, are blowing air to clear out the powder smoke, and this cost is proportional to the number of machines in operation. However, I believe that stopes are the biggest users of the 80 to 90 per cent of the compressed air unaccounted for. Leakage, of course, is important, but the common practice of "blowing" compressed air in hot and poorly ventilated stopes uses vastly more air than is charged. The practice of "cracking" an air valve is badly abused. In my opinion one such valve will release more air than a hundred leaks which are scarcely audible. In other words, the air used in blowing is likely to amount to several times that used in drilling, and in consequence one common method of air distribution is far from accurate. In most operations, much more air should be charged to stoping and less debited to development work.

In entering charges for rails used in drifting, a choice as to how they should be charged is possible. In some instances, they are charged directly to stoping, on the ground that they will eventually be used for transporting ore and, therefore, should be charged to the ore being produced. Only under exceptional conditions are they charged to the drift being run. In my opinion rails should be charged to the drift for the reason that the prospecting and development account should be known as accurately as possible. However, in some operations drift rails should be charged to stoping.

Opinion as to methods of charging differs with respect to certain other supplies also.

Any cost system is based on more or less arbitrary decisions. Some logical reason upon which charges can be segregated can nevertheless be found. My own preference is that mining costs should be segregated into two main divisions: (1) prospecting and development costs and (2) mining or stoping costs. These should be followed with pumping, hoisting, transportation, and miscellaneous costs.

Cost sheets rarely show the total cost per foot of drifting or raising. Certain costs are obtainable, such as labor and explosives, but few comprehensive cost statements have been published, for the reason, mainly, that they are not kept. Many costs directly chargeable to drifting find their way into other accounts, and inaccuracy results.

The most accurate costs of development are likely to be those obtained when outside work is being undertaken by the company. In this work no difficulties are met in making segregations. All costs can be kept accurately, as no need exists to estimate the division of charges between stopes and drifts.

THE keeping of mine cost sheets presents many difficulties. If the system used is not simple, it does not meet the needs of the foreman and shift boss. For their needs, accurate total costs of development work per foot are of no great value. Of principal interest is the cost per foot of labor and powder. If these are too high, they can take steps immediately to remedy the condition. On the other hand, the cost of rails, track ties, pipe, supervision, ventilation, compressed air and the many other items which go to make the total cost of drifting, are of great importance to the management.

Statements made herein manifestly do not apply to all mines, because in some accurate methods are used. In general, the subject of mine accounting is worthy of more study in the hope that a simple, more accurate, and consequently more valuable method of cost keeping will be evolved.

Cyaniding 40-Mesh Pulp at Red Lake, Ontario

W. M. Goodwin

Ontario's latest gold mine, the Howey, has many notable features. It is being operated 175 miles from a railway; it is already the cheapest gold producer in Ontario; and its costs promise to approach those of the notable low-cost mines of the world. Milling practice involves features that are new in Canada and not common elsewhere. The results achieved in the mining of a large and compact orebody, with cheap power, a remarkably simple and effective metallurgical flowsheet, and low cost of transportation afford an object lesson that will be of considerable value in the development of gold mines in northern Canada and elsewhere.

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THE only substantial producing gold mine in Ontario at present outside the two large camps, Porcupine and Kirkland Lake, is the Howey. This is at Red Lake, in the far western part of the province near the Manitoba boundary. Howey is operated profitably at a distance of 175 miles from the railway, with costs as low as or lower than those of any other gold mine in the province. The surrounding area, although it has not yielded, up to the present, another mine, is now the field of operation of real prospectors. Results of their search during recent months have been highly encouraging and may turn Red Lake into Ontario's third big gold camp. I recently inspected the Howey mine, and the following notes were taken at that time:

Red Lake is in the District of Patricia, 175 miles by water route from Hudson Station, on the Canadian National Railways. This route is remarkably good, for comparatively large steamers operate for two-thirds of the distance on Lac Seul, as far as its outlet at Ear Falls, near Gold Pines, where there is a dam and water power capable of developing 25,000 hp. At Ear Falls freight is transferred to 10-ton scows, which are towed down the English River a few miles and then up a tributary, the Chukuni River, to Red Lake. On the Chukuni River are two rapids, round which the scows are taken, without unloading, on marine railways. The cost of transporting freight from the railway to the Howey mine is at present $40 a ton. This adds only a few cents per ton to the cost of treating the ore.

A mail and passenger service is conducted by airplanes, which operate winter and summer with equal facility. Their headquarters is Sioux Lookout, 12 miles east of Hudson, a town with banking, hotel, and other facilities that makes a good "jumping-off place." A visit to Red Lake can therefore be made with the utmost ease and speed. One leaves Montreal, Toronto, or Winnipeg on one of the transcontinental trains of the Canadian National Railways, takes a taxi to the hangar of Canadian Airways, Ltd., steps aboard the hydroplane that carries His Majesty's mails, and in an hour and a half lands at Red Lake, after a glorious trip above one of the best-watered portions of the continent. On Red Lake and its numerous arms, a fast motor boat makes practically any prospect readily accessible. To those accustomed to the old foot-slogging and paddling method, these facilities constitute prospecting and mining "de luxe."

The Howey mine is a model of expeditious development. It was discovered in the fall of 1925, and was diamond-drilled in 1926. In 1927 and 1928 the mine was developed on four levels, to a depth of 500 ft., with 12,000 lineal feet of lateral work and 6,000 ft. of diamond drilling. During 1929 development was extended on four more levels to a depth of 1,000 ft., with 4,000 ft. of lateral work. In the summer of 1929 the construction of a 500-ton mill was started, and this plant was placed in operation in March, 1930. Thus, two years and nine months after the first small steam plant was landed on the property, the mine was developed to 1,000 ft. in depth and a modern 500-ton mill completed. The plant is operated by electric power received from a hydroelectric installation at Ear Falls, 40 miles away. These achievements are due to the faith and energy of John E. Hammell, who took the property over from the prospectors who found it, and to the skill of Horace G. Young, who managed the property throughout and who achieved this record speed in spite of the distance from the railway.

The Howey ore deposit is part of a dike of porphyry, a part of which has been sheared and intersected by irregular veins of quartz. Both the quartz and the porphyry within the ore zone are mineralized liberally with pyrite and sparsely with other sulphides. Although coarse gold is found occasionally, the bulk of the metal is fine and evenly distributed. The dike contains gold for several thousand feet in length and across its full width of 80 to 120 ft.; but the payable concentration, so far as exposed, is mainly within a zone about 1,000 ft. long on both sides of the Howey shaft and from 10 to 50 ft. or more in width along the footwall of the dike.

When the mine was first opened to a depth of 500 ft., the intention was to mill only the higher-grade portion of the ore deposit, averaging $6.50 across 16 ft. But as development continued the stopes could apparently be made much wider than this with profit, at the expense of lowering the grade. In consequence, the mine as developed at

Surface plant at the Howey mine. Headframe and crushing plant are at the left; the mill and office building are at the right.

present averages $4.65 across 34 ft., the profitable ore being increased by one-half by this widening of the stopes to double the original estimate. The additional 18 ft. of ore of $3 average grade is obtained without any appreciable additional development—merely at the cost of widening the stopes.

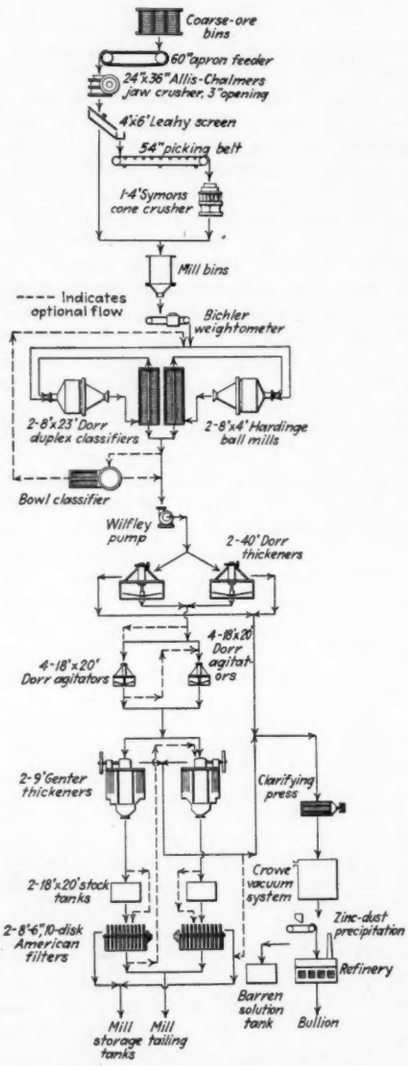
Stoping operations during recent weeks on the two lowest levels, at 875 and 1,000 ft., tend to show still greater widths of ore, of better than average grade. The stope on the 1,000 level, for instance, at the time of my visit, in May of 1931, was 260 ft. long and averaged $6.09 for a width of 44 ft. Diamond drilling from the haulage drift beneath had indicated the same value and width for several hundred feet additional in length. But a still more interesting feature was the fact that some crosscuts over the full width of the gold-bearing zone, 80 ft., showed a payable grade for the whole distance, so a good reason exists for hoping that the stoping width on this level will reach 80 ft.

These wide and long stopes, one below the other in compact fashion, permit of unusually low costs, both in development and in extraction. This provides one of the reasons for Howey's low total costs. The ore is continuous and free from cracks or slips. Moreover, it drills and breaks well, so no problems arise in stoping even these great widths. Shrinkage stoping is used, and the ore is trammed to ore passes, through which it moves to two levels for hoisting.

The simple milling of the Howey ore comprises the second important reason for the low total cost. Preliminary tests indicated that grinding to 40 mesh would give an excellent extraction with straight cyaniding, and the plant was designed to this end. The accompanying flowsheet, prepared by R. M. P. Hamilton, who installed the mill on behalf of General Engineering Company, illustrates its features. It was designed to treat 500 tons a day, and has proved to be of 600 tons' capacity. The mill building and units are disposed so that the present tonnage can be doubled by simply increasing the grinding, classifying, and filtering sections. This can be done at a trifling expense and on short notice. The crushing plant, adjoining the 106-ft. headframe, has lately been adjusted to include a 60-in. apron feeder and a 54-in. picking belt, along which, six men are employed taking out waste. This raises the mill grade 50c. a ton.

The most striking feature of the mill practice is the fact that 95 per cent or more of the gold is recovered by grinding to 40 mesh. At first a belief prevailed that the coarseness of this material might cause serious trouble in some parts of the mill; but simple adjustments overcame all such difficulties as soon as they appeared. As indicated by the flowsheet, the arrangement is the simplest possible for a cyanide mill. It is operating smoothly and efficiently. A feature impressive to a visitor is the position of the classifiers following the ball mills, which are placed above the mills instead of below, as is customary, thus permitting the mills to be on an unobstructed floor at a low level. This arrangement has been proved to be a particularly convenient one.

As already mentioned, Howey costs are notable among the gold mines of Ontario, owing largely to the advantages of a large and compact orebody and easily milled ore. During the last year the total cost per ton, including interest on a half-million-dollar loan, but excluding charges for depreciation and taxes, has ranged from $3.25 to $3.60 per ton. Throughout this period the shrinkage stopes have been filling up and in May the first two were completed. From now on, therefore, 200 tons of ore a day will be drawn from broken reserves, which will reduce the average daily cost about 50c. a ton. This, with the economy effected by hand sorting of waste, will reduce the cost to $3 per ton or less. If, and when, the mill tonnage is doubled, the cost per ton will again be reduced considerably below $3 a ton, probably to about $2.50. Flotation may possibly be employed, to effect a further economy. Tests to this end are still under way, but a decision has not yet been reached.



Flowsheet of the Howey metallurgical plant

Substantial indications exist, as noted previously, that the deeper sections of the Howey deposit are both larger and of higher grade than the upper levels. Not only have stoping operations on the 875 and 1,000 levels shown greatly increased widths, but drifts now under way have revealed unexpected lengths of ore. Levels below 1,000 ft. will therefore probably disclose ore in sufficient volume to warrant eventually a much larger increase in daily tonnage than the doubled capacity now being considered. In fact, a reasonable operation to envisage at the Howey a few years hence would be one of 3,000 or 4,000 tons a day, with costs reduced materially below the $2.50 suggested for a 1,000-ton mill. But this will have to await deeper mine development to, say, 2,000 ft.

Average costs when 15,500 tons a month of ore is being treated are as follows: Development, $0.15; haulage levels, $0.02; boxholes, $0.10; mining, $1.75; crushing and conveying, $0.16; milling, $0.81; general, $0.17; head office, $0.34; total, before depreciation and taxes, $3.50. The plant will handle 18,000 tons a month, and the above costs on that basis will drop to about $3 per ton.

The achievement of Horace G. Young, who has developed the Howey to the present stage, consisted mainly in overcoming the difficulties of transportation and establishing a variant of the usual cyanide practice that has reduced costs considerably. But the work under way will permit the mine to do far better than it is doing at present. The lower levels show a marked improvement both in volume of ore and in grade, which, if it carries down, will support a daily output considerably beyond the 1,200 tons contemplated in the present mill. But, even by doubling the present 600 tons a day, more effective mining methods can be adopted, and this, with the decreased cost of milling, will bring down the over-all costs to $2.50 a ton or lower. Meantime the Howey marks an advance that has encouraged the examination of other large, low-grade gold deposits, suitable for beneficiation by a simple metallurgical process.

Schaefer Concrete Arch Supports for Mine Roofs

Edward H. Robie
Associate Editor

Arches may be separated by concrete lagging as shown here

THE Schaefer method of roof support is not new to coal-mining engineers, but few metal-mining engineers are familiar with it or have envisioned its possibilities in their field. In May, the anthracite section of the A.I.M.E. was host to a visiting group of engineers, some of whom had never been in a coal mine before and who found much of interest in some features of practice in the anthracite field of Pennsylvania. Among these was the method, herewith described and illustrated, of supporting roofs in some of the workings at the Powderly mine of the Hudson Coal Company, at Carbondale, Pa.

The form of concrete blocks used, and the method of setting them in place, is the invention of Hanns Schaefer, a mining engineer of Essen, Germany. His ideas have been patented, and the method has been applied in German mines for ten years or more, and also in England. Not until two or three years ago, however, was the method introduced into America, at the Powderly mine. Sufficient time has now elapsed to prove the worth of the installation as a substitute for ordinary timbering. It is more expensive but appears to be considerably more durable, being stronger in the first place and also showing no tendency to deteriorate at the end of a few years, as does timber. The management of The Hudson Coal Company considers that it is economical to install Schaefer lining if the expected life of the opening

Types of concrete block used lining

Continuous Schaefer arch, showing use of compression blocks

to be protected, and the physical conditions regarding deterioration of timber, are such that it is probable that a given set of timber will have to be renewed during the life of the opening. In other words, the Schaefer lining costs more than the initial timbering, but costs less than initial timbering plus retimbering.

Briefly, the Schaefer method consists in building an arch from a prepared footing on the floor at each side of the tunnel, using pre-cast concrete blocks of special shapes in blocks weighing about 75 lb. each. No mortar of any kind is placed between the blocks, but at intervals compression members are introduced, these being creosoted yellow pine blocks, 2 in. square. Some of these retain their shape for a year or more; others, incorporated in the arch under heavy shifting ground, may be squeezed to a thickness of a fraction of an inch. The general shape of the blocks is that of a very thick "T," the face of the block, or top of the "T," being 18 in.

Pump room, before and after relining

long. In the shank of the "T" a hole is cast, so that when the blocks are in place a continuous hole in the concrete extends around the arch, paralleling its face. In this, short lengths of discarded wire rope are grouted. This rope will hold one of the concrete slabs in place even though the arch becomes deformed to such an extent that the normal keying action is lost. The arch is therefore exceedingly flexible without losing much of its strength. At some points in the Powderly mine, deformation is very evident, but no cracking of the concrete blocks, or failure of the arch, has yet been experienced. The distortion may be in any direction, downward or longitudinally.

Channel-steel rings are used as forms in building the arch, as shown in the accompanying photographic reproduction. As originally made in Germany, the arch was continuous longitudinally, making a smooth wall and roof throughout the length of the tunnel or other opening. Where conditions are not so severe, however, a modification has been made in this mine to cheapen the cost. This consists in lagging the roof for a space of two or three feet between adjacent concrete arches, slabs of concrete being used for the lagging. This idea is also made clear in one of the illustrations.

One interesting instance of the application of this method of roof support at the Hudson Coal properties is the repair made to a large pump room. This was rebuilt this spring with Schaefer lining 22 ft. in diameter. This pump room is an old one and was formerly lined with reinforced concrete side walls and an arched brick roof. These substantial structures were wrecked by ground movement, as the photograph shows. The broken masonry work was removed in 3-ft. sections and the new Schaefer arches were immediately installed, with no stoppage necessary in the operation of the pumps.

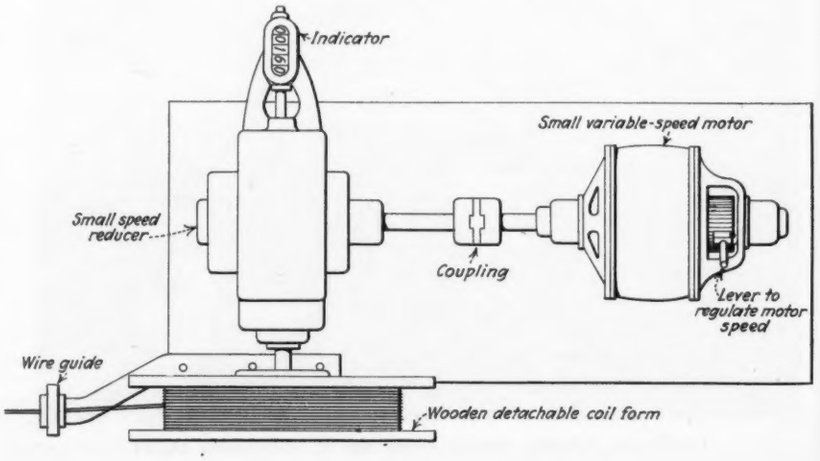
Several metal-mine engineers who witnessed the work being done with the Schaefer method at the Powderly mine were confident that it could be applied profitably in many drifts and tunnels of properties other than coal mines. In fact, one of them intimated that several hundred thousand dollars might have been saved at one property in the last few years had this method been used, rather than the more expensive monolithic concrete lining and support that had been constructed.

■ ■

Motor-Coil Winding Machine

WINDING motor coils by hand is a slow and costly procedure. If not accurately performed by a skilled operator, poor motor performance will result. To reduce costs and maintain a high motor efficiency throughout the plant, the installation of a mechanical coil-winding machine at every electrical shop is a necessity. A practical and efficient machine, recently developed at the electrical department of the Calumet & Arizona Mining Company's New Cornelia mines, at Ajo, Ariz., is shown in the accompanying illustration. The apparatus consists of a small speed reducer, coupled to a variable-speed motor; a wire guide, made of light strap iron; and the wooden coil form, attached to the shaft of the winding unit.

Correct winding is facilitated by a small indicator, attached to the speed reducer, which indicates the exact number of revolutions made by the coil form. The motor speed can be controlled by the operator with a lever device installed at the commutator end of the motor. To manufacture coils of various sizes, corresponding forms are always kept on hand.



The Gold Mining Industry in the U.S.S.R.

In Retrospect and in Prospect

V. M. Karmashov

MINING of gold in pre-War Russia was in a highly undeveloped state, and was to a large extent conducted by numerous small prospecting companies, by hand methods of recovery. Of a total of 1,053 enterprises operating in 1913, only eleven produced more than 400 kg. of gold annually; 30 to 50 had an output approximating this figure; the remainder, about 1,000 enterprises, had a production below 51 kg. a year.

These figures show that 22 per cent of all gold produced originated from veins, and that 78 per cent was placer gold. Mechanical mining methods were employed for only 25 per cent of the total; the remaining 75 per cent was mined exclusively by hand methods. Even in the famous gold fields of the Urals and the Lena River, 95 per cent of the mining was by hand. Methods of separating and recovering the precious metal were also primitive, the average recovery by amalgamation methods being 56 per cent and by the cyanide process 79 per cent.

The main reason for the primitive state of affairs here recorded was the ignorance of the great majority of the prospectors, who failed to comprehend the importance of engineering methods and technical skill. Owners, furthermore, were chiefly concerned not with methods of mining and recovering, but with trading supplies for gold. Another contributing factor was the small number of engineers and technicians available. Mining and recovering were thus left to working crews consisting of from five to ten men, often illiterate, with methods very little improved since the days of Homer. Rich deposits were drained and material of lower grade was covered up. All gold produced in the regions of Trans-Baikal and the Amur River, for instance (22,334.8 kg. in 1911; 21,864.6 kg. in 1912; and 21,573.1 kg. in 1913), was extracted by primitive methods.

Capital investments in the gold fields were insignificant. According to a statement of twenty companies, published in 1913, their aggregate capital investment amounted to $40,000,000. For the remaining 1,033 companies the total investment was $17,500,000. Thus, capital investment in the entire industry, with a yearly production of $32,000,000 of gold, amounted to $57,000,000, of which $22,500,000 represented cost of construction and equipment and $35,000,000 the working capital.

Gold production figures for the last fifteen years are given in Table II.

Table I—Production of Placer and Vein Gold in the Principal Gold Mining Districts for the Period 1909-1913

(*In Kilograms*)

	The Urals		Western Siberia		Eastern Siberia		Total	
Year	Placer	Vein	Placer	Vein	Placer	Vein	Placer	Vein
1909	4029.6	5340.0	1425.1	1277.7	43,735.9	982.8	49,190.6	7600.6
1910	4602.9	5913.4	1867.4	1998.4	48,666.4	606.1	55,136.7	8517.9
1911	4177.0	5913.4	2031.2	2014.8	46,209.4	704.4	52,417.6	8632.5
1912	4570.2	6421.2	1687.2	1638.1	43,260.9	655.2	46,518.3	8714.4
1913	5290.9	6437.5	1474.2	1801.9	45,996.4	835.4	51,795.1	9058.4

Figures have been taken from the Soviet Journal, *Tsvetnye Metally* (non-ferrous metals), No. 5, 1930.

These figures do not include gold produced as a byproduct in copper and lead smelters, located in the Urals, Ridder, and Armenia. This totaled about 5,000 kg. yearly.

Table II—Gold Production in Kilograms

Year	Kg. Gold	Year	Kg. Gold
1914	49,245	1922–23	11,179
1915	40,934	1923–24	20,000
1916	25,619	1924–25	25,258
1917	25,881	1925–26	25,149
1918	21,163	1926–27	22,600
1919	6,514	1928	23,000
1920	4,311	1929	25,000
1921–22	5,773	1930	29,000

All wage figures do not include special bonuses received by workers as per Soviet labor laws, vacation with pay, free medical help, sick benefits, and free or very low rentals.

Table II shows a steady decline in gold mining from 1915 to 1920, production in the latter year amounting to slightly less than one-twelfth of that in 1913. The reasons are obvious. In the first place, primitive mining methods required a large number of laborers; second, the World War and the Russian revolution interfered with the activities. The weakening of the entire economic structure of Russia, especially the disorganization of food supply and the system of distribution, forced many prospectors and gold seekers to abandon their work in the vast and dreary Siberian "Taiga." A sharp decline in mining activities resulted. The number of men employed in the gold fields and average wages are shown in Table III.

Table III—Employment and Wages

Year	Number of Men Employed	Monthly Wages in Dollars
1913	50,000	30.00
1927	5,865	38.00
1928	15,468	39.50
1929	30,719	87.00
1930	43,293	52.50

Figures for 1929 and 1930 have no official character and are merely a result of the author's computation.

From the days of the revolution to the year 1928 the gold fields of the U.S.S.R. were managed by a few independent government combines. In 1928, the Soviet government established a centralized board, the "Soyuzzoloto" (united board of the gold mining industry). A balance sheet published by this board in 1928 gives the following data: Cost of structures and equipment in the gold fields amounted to only $7,750,000; number of men employed was considerably less than in the pre-War year 1913. Also, the amount of capital invested had been markedly reduced. To invest new capital to mechanize mining methods and to develop prospecting was the first task facing "Soyuzzoloto." In 1928 $10,500,000 was invested; in 1929, $18,400,000; and in 1930, $20,000,000. These investments have already produced results, as seen from Table IV, giving the ratio of placer gold to vein gold for the years 1913-31.

The increased capital investment was used mainly for the construction of dredges and amalgamation and cyanide mills, and for equipping placers with mechanical means of extraction.

The resulting growth in numbers of gold-producing units from 1928 to 1931 is shown in Table V.

In conclusion some data are presented showing new work of prospecting and development of newly discovered deposits of placer and vein gold. The great potentialities of the gold-mining industry of the Soviet Union lie in the vast stretches of Siberia and Turkestan from the Urals to the Pacific and the Arctic coasts. Prospecting during the first year of the Soviet régime revealed that the known fields were being exhausted. Large amounts have been appropriated for prospecting—$1,500,000 in 1928, $4,500,000 in 1929, and $7,000,000 in 1930. The first two years'

Table IV—Ratio Placer Gold to Vein Gold, Per Cent

Year	1913	1926	1927	1928	1929	1930	1931
Placer	85	83	80	78	75	74.5	67
Vein	15	17	20	22	25	25.5	33

prospecting has increased the tonnage in known deposits 40 per cent.

In addition to the newly discovered placer deposits at the head of the Aldan River (a large tributary to the Lena River), producing up to 5,000 kg. of gold per year, three more important placer deposits have been discovered: (1) along the banks of the Kolar River, a tributary to Olekma River; (2) at the head of the Vitim River; and (3) at the head of Upper Kolima River, the latter ranking next to the Aldan deposits in importance. An expedition headed by the geologist Obruchov mapped out the boundaries of the gold-bearing zone of Upper Kolima—700 km. in width and 200 km. in length.

Table V—Gold Producing Units

Year	1928	1929	1930	1931
Amalgamation mills	44	55	74	77
Cyanide mills	13	20	30	40
Dredges	24	29	34	38
Hydraulic installations	21	53	78	94
Scrapers	..	..	7	17
Excavators	..	2	4	5

Evidence of placer and vein gold has also been found in the six southern promontories of the Chersky Range (a branch of the Stanovoy Range).

The most important of the newly discovered veins are the Balei mine, near the city of Sretensk, in eastern Siberia, and the Manka mine, in eastern Turkestan. The Darasunski mines, in the district of Chita, for some time known to contain gold ore, were not explored until recently. At present they are being worked and exploited.

Development of Kyanite Deposits

INTEREST in the use of kyanite as a ceramic raw material was aroused soon after the War. The U. S. Bureau of Standards made important observations on the value of artificial sillimanite in the manufacture of high-temperature porcelain for electrical work. This directed the attention of several scientific investigators to the field of the natural aluminum silicates. Three members of the topaz group—andalusite, sillimanite, and kyanite—when heated were observed to invert to a substance known as mullite. Further investigation showed that the properties of mullite corresponded closely to those of the artificial sillimanite produced by the Bureau of Standards. The chemical composition was identical. This observation led to a wide search for deposits. A large deposit of andalusite was discovered in the Inyo Mountains of California. Another, containing a mixture of kyanite and pyrophyllite, was found in southeastern California. Others were reported from Death Valley and New Mexico. Geological literature was searched, the numerous references to the occurrences of these minerals were noted, and many examinations followed. Development work was undertaken on the deposit at Charlotte Court House, Va. This activity in the field was accompanied by detailed research. Papers were published by leading physical laboratories in the United States, and a general conception of these minerals became known to most ceramic manufacturers. Unfortunately, in some areas in which these minerals were known to occur, exaggerated ideas of their value existed. Reports were circulated that a panacea for all the ills of the ceramic industry had been discovered in kyanite, and that an unlimited market at fabulous prices had been created.

When a great industry failed to develop in an area known to contain large deposits of kyanite, the cause was not apparent to many. A consideration of the facts actually developed during the last ten years will aid in clarifying the present problem.

The uses of kyanite fall into two general classes: (1) the field of high-temperature and electrical porcelains; (2) the refractory field. The first class includes such articles as spark plugs, pyrometer tubes, chemical and scientific porcelain, special grades of oven ware, and electrical specialties. In this field the requirement is obviously small but steadily growing. The andalusite from California now supplies nearly all of this demand. To compete in this field, a kyanite must be extremely pure and almost free from iron and any other impurities that will discolor or impair its electrical properties. It must be remarkably uniform in grade. Even very slight variations in chemical analysis of two shipments would preclude its use in this special application. A careful study must be made to observe its exact inversion temperature, and this also must be constant in all parts of the orebody from which shipments are to be made. Similarly, careful observations are necessary to determine the expansion and contraction coefficients within various temperature ranges. Many other physical properties are of greater or lesser importance, depending upon the use to which the material is to be put. The price of the raw material is important, of course, but superiority of product is paramount, and high-grade material commands a good price.

In the much larger refractory field, the specifications are not quite so rigid as far as appearance is concerned, but uniformity of product is still important. The price consideration in this field is also of great importance. That addition of kyanite to a refractory body improves its characteristics is generally acknowledged, but at what point the advantage of the addition of kyanite offsets its higher cost is a problem for study at the plant. It can be worked out only by co-operation between manufacturer and producer of the raw material. Additional possibilities for development lie in the direction of refractory cements and special porous bodies.

From the foregoing statement of the requisites of a commercial kyanite product the conclusion is obvious that many problems must be met before a successful venture can be launched. Too much stress cannot be laid on the importance of determining the uniformity or lack of uniformity of the deposit. In several instances during the last ten years, selected specimens from various deposits have been the subject of considerable laboratory investigation. Favorable results were obtained and published, but when the commercial product was eventually placed on the market, the results indicated in the laboratory could not be duplicated in practice. This represented no lack of sincerity on the part of the producer, but merely a lack of proper consideration of the value of uniformity.

The problem of developing kyanite deposits, in its first stages at least, therefore appears to be largely of a technical nature. In their sequence the requirements seem to be: (1) to locate a deposit of considerable size; (2) to determine its average kyanite content; (3) to observe, in a preliminary way, the physical properties of the particular kyanite occurring; (4) to determine efficient and economical means of securing the requisite purity and uniformity demanded in the finished product; and (5) to investigate the market requirements and the possibilities in the particular field for which the product seems most suitable.

Abstract from a paper by V. L. Mattson, read before the Southern Appalachian Mineral Society, June 6, 1931.

IRON MINING

A. H. Hubbell
Associate Editor

On The Gogebic Range

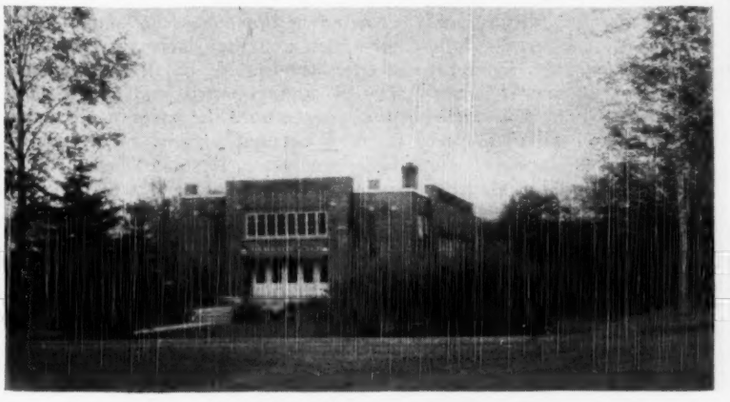
Details of Practice at the Montreal

WHAT might properly be regarded by an engineer or a layman as one of the show places of the Lake Superior Iron Country is the Montreal mine, situated in Wisconsin about three miles west ot Ironwood, Michigan, on the Gogebic Range. In its attractive surface plant and the abundant evidence of able, efficient management on surface and underground, it offers much to excite the interest of the visitor. Last fall it was made the subject of one of the Bureau of Mines' series of papers on mining methods. (I. C. 6369. "Mining Methods and Costs at the Montreal Mine, Montreal, Wis." By O. M. Schaus.) During the past May, while on the Gogebic, I was privileged to visit the mine through the courtesy of Mr. E. W. Hopkins, then manager for Oglebay, Norton & Company, who operate the property for the owners. On this occasion Mr. Hopkins turned me over to Mr. R. A. Angst, his general superintendent, who sent me underground with Mr. Leslie E. Dick, assistant superintendent of the mine. Mr. R. A. Bowen is superintendent of the mine and Mr. L. D. Stewart, chief engineer for the operating company. Recently the report has been received that Mr. Hopkins has retired from the management.

Observations made on points not covered in Mr. Schaus' paper, together with photographs of the surface plant, are presented in the following, which thus may serve as a supplement to the Bureau's paper for those who have the latter. For the benefit of others, these notes are prefaced by a short summary of Mr. Schaus' article.

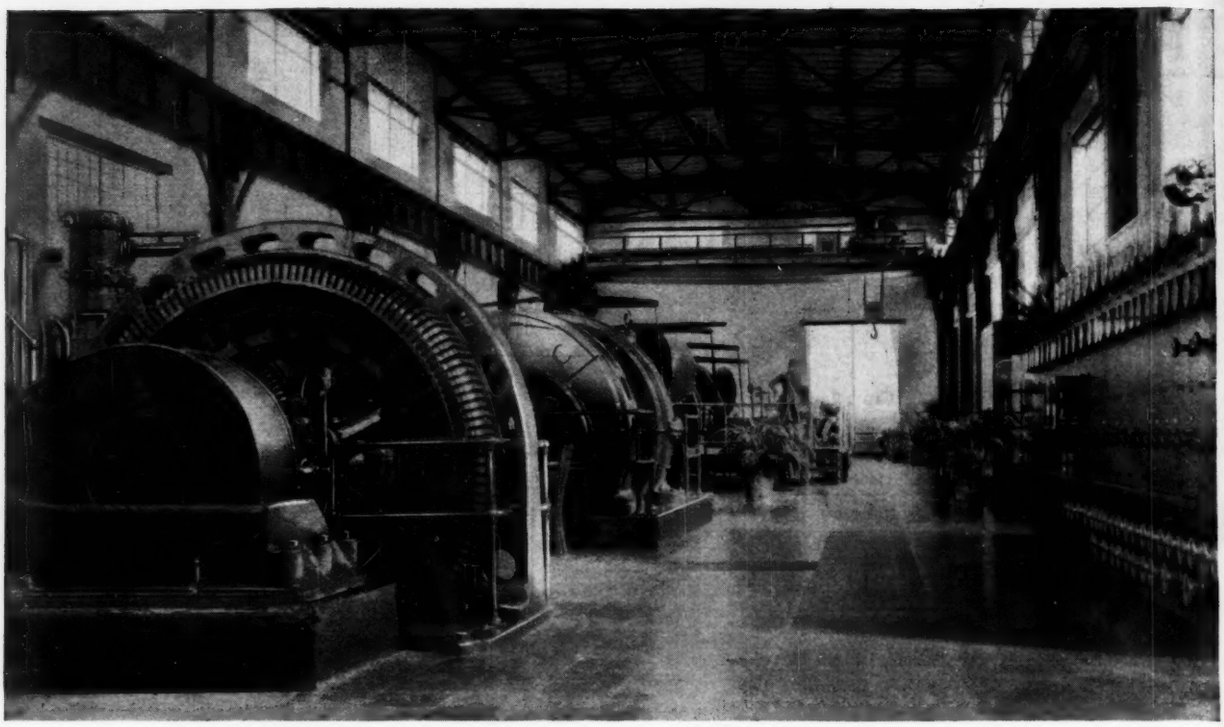
Hematite was discovered on the property in 1885, according to Mr. Schaus. Production capacity is now over 1,000,000 tons a year, which point has been reached by a steady growth, save for a lapse in 1921. Three grades of ore are mined, bessemer, non-bessemer, and manganiferous, the first two running slightly over 60 per cent iron, and the third 54.50 per cent iron and 5 per cent manganese. In phosphorus the grades run 0.045, 0.065, and 0.070 respectively, and in silica 7.80, 8.20, and 8.60. The ore occurs principally in troughs formed by the intersection of dikes with the impervious members of the formation, which dips about 65 deg. It also occurs in irregular chimneys following cross faults above the dikes. The ore is in general soft enough to be drilled with auger drills, but ribs of hard blue ore occur, requiring mounted hammer drills.

No. 5 shaft house, Montreal mine, seen through the trees. To the left of the latter is the clubhouse shown, also illustrated



Clubhouse for Montreal Mining Company's employees

Three shafts are in operation, two inclined and paralleling the dip, the other vertical. The level interval has been varied to suit conditions. Average vertical depth of mining is 2,000 ft., and the maximum is 2,550 ft. Each shaft has five compartments accommodating one cage, two skips, pipes and cables, and a ladderway. The vertical shaft (known as No. 5 and shown in the accompanying illustrations) is centrally located and 3,000 ft. deep, and is equipped to handle the total tonnage. It is timbered with 6-in. H steel on 7-ft. centers without lath, the walls being gunited. The skips in it hold 8 long tons each; those in the inclined shafts, 5 tons. In the inclined shaft, however, cages only are operated, handling men and materials.



Interior of the hoist and compressor building, Montreal mine. One of the compressors on the left and beyond it the cage and skip hoists

Mining is done by sublevel caving and in sublevel open stopes. Broken ore and rock from development are mucked with scrapers operated by double-drum, 250-volt, d.c. slusher hoists. Scrapers range from 30 to 54 in. in width and include hoe-type and box-type. Hoists range from 7½ to 25 horsepower (including 10 and 15 hp.). Portable steel slides are used with the 15-hp. hoists for loading cars. A specially designed 320-cu.ft. car, including slide and hoist in one compact unit, is used in double-track development work. Ore is transported on main haulage levels in 40-cu.ft. (2¼-ton) round-bottom rocker-dump cars by 2-, 4-, and 6-ton trolley locomotives, track grade being 0.5 per cent in favor of the load.

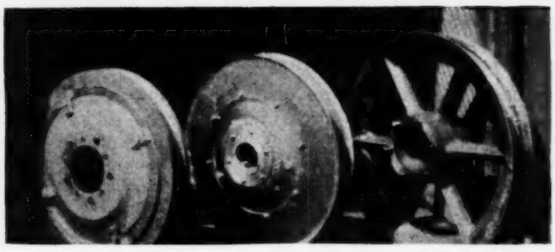
Pumping is done principally from the 2,000 level of the main shaft, most of the water flowing to this point. The water made approximates 900 g.p.m. on an average. Pumping is done with three 750-gal. horizontal duplex pumps, each driven by a 400-hp. 2,300-volt synchronous motor.

So much for the Bureau paper. It contains a vast amount of other useful detail, including costs, not susceptible of being summarized or condensed within a few paragraphs.

As for my own observations, beginning with the surface: The Montreal plant offers an excellent object lesson to those engineers who, limited to the strictly utilitarian in their vision, hold, or appear to hold, if one may judge from their works, that a mine plant may properly be an eyesore, if only it be efficient. Two of the accompanying photographic reproductions will give the reader an idea of the results obtained by the management in its effort to make their surroundings attractive to the workmen. One of these shows the inclosed headframe at the main, or No. 5, shaft, as seen through the near-by trees from the shops. The other pictures the Hamilton Club house, adjacent to the shops, in its setting of shrubs and greenery. The shaft stands to the right of this building and further from the camera. Attractive within as it is outside, the clubhouse, which is intended for the entertainment of all employees and their families, has facilities for lounging, bowling, billiards, and other recreations. Its principal feature, however, is a theater, originally equipped for moving pictures but now housing one of the finest and most complete talking-picture installations in the country, according to Mr. Stewart. Suggestions of the electrical manufacturer were followed to such an extent that the installation is now pointed to as a model by the latter.

Similarly appealing to the eye is the interior of the hoist and compressor building serving No. 5 shaft. Its attractiveness is inadequately shown in the accompanying illustration. Indeed, as a rule, the hoist house is the most attractive part of a mine plant in the Iron Country. But at the Montreal, the actual beauty of the machinery (for a modern mine hoist or a motor-driven compressor is really beautiful, especially when in motion) has not satisfied the hoist men and they have increased the artistic atmosphere of their surroundings by adding potted palms, ferns, and other plants, until the parts of the building thus favored suggest a greenhouse. The floor space, it should be added, is sufficiently ample to permit this. Those eminent citizens who so often lament the ugliness and hopelessness of the machine age, as they call it, should visit such plants as this and get a good start toward a different mental conception.

Skip and cage hoists at No. 5 are duplicates. Each is a double-drum Nordberg, winding 3,000 ft. of rope and able to take 4,500 ft. in two layers. The drums are of steel-plate construction, with parallel grooves. Originally they were of cast iron and had spiral grooves.



Three idler-stand rope sheaves. Right, that now in service at Montreal No. 5 shaft; weight 200 lb. Left and center, experimental sheaves, lighter than that now used but still too heavy

All drums are clutched. The ore hoist is direct-connected to a Westinghouse slow-speed rolling-mill-type motor (2,300 volts, d.c.).

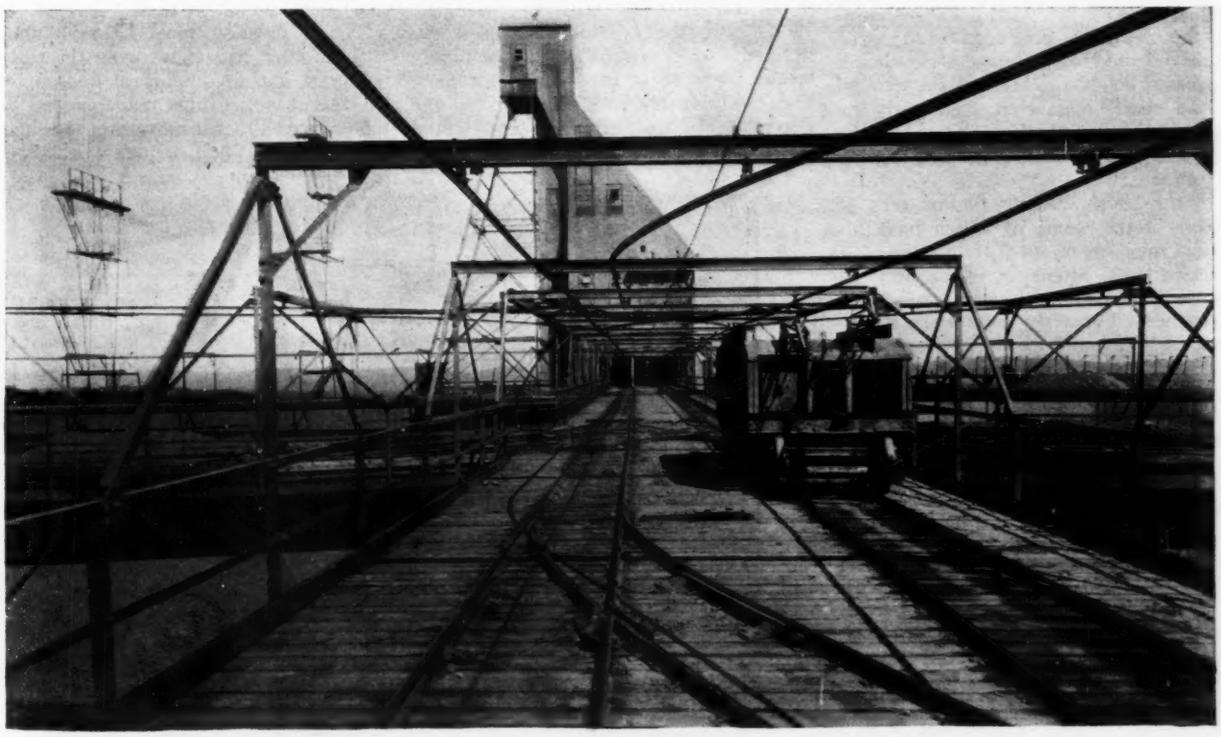
No. 5 shaft house is 165 ft. high. It is shown in the illustrations. A novelty is the use of a photo-electric cell on the headframe members which signals the hoistman whenever a skip goes into the dump or comes out of it. The skipways are spanned by a beam of light, the ray projector and the receptor being on opposite sides of the shaft so that one cell serves both skips. Whenever a skip intercepts this beam, a lamp lights up on the hoistman's panel. This is the second of two applications of the photo-electric cell that I noted recently in the Iron Country, the other being at an ore-sintering plant in Minnesota, at which one of these cells is used to control the speed of the sintering machine to assure a bed of even depth.

For crushing preparatory to shipment, the headframe houses a No. 13 Telsmith primary breaker, set to 2¾ in. discharge. This is driven by a 50-hp. motor at 425 r.p.m., the flywheel drive pulley having a 48-in. diameter and a 14-in. face. The crusher has a cast-steel frame, manganese-steel head and concaves, and high-pressure babbitt is used in the bearings. It is equipped with an automatic oiling system.

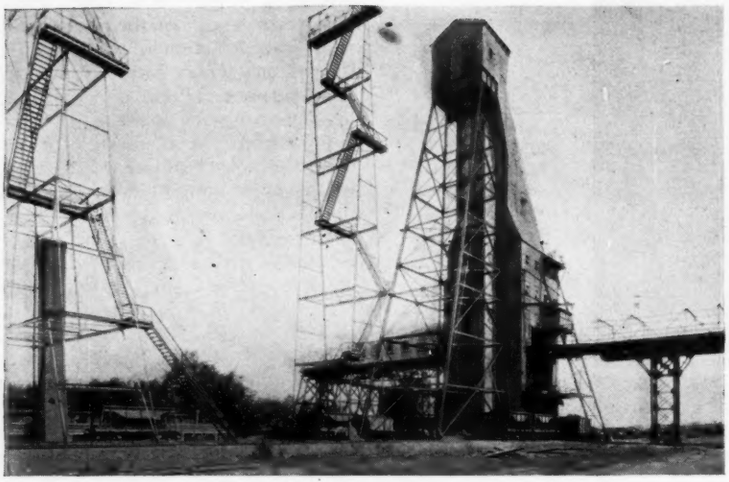
This shaft is equipped with the induction system of shaft-signaling devised by Mr. Stewart and described by him in a recent issue of this publication. As he explains therein, he designed this system primarily to insure the safety of the person giving the signals by enabling him to give them from the cage after its safety gates and those on the station landing have been closed. With it the cage tender can signal or talk by telephone to the engineer at all times without leaving the cage, whether this is at rest or in motion. The equipment as used today is practically the same as described and illustrated, save that the means for supporting the shaft aërials has been modified and the metal box housing the telephone on the cage has been trebled in length to accommodate the batteries and coils. Instead of the ordinary side-supporting trolley hanger formerly used for supporting the aërials, the clamp shown in the illustration has been devised by Mr. Stewart and is now in service. It is hung on the shaft set and holds a short length of corrugated rubber hose through which the aërial passes, the wire being kept taut by a weight on its end. Thus any change in length of the wire by expansion or contraction is without effect on the system, which formerly was subject to disturbance by reason of the method of supporting the wires.

New means devised for keeping in place shaft aerials used in induction system of safety signaling

Owing to the distance of the shaft from the hoist building, idler stands are necessary to support the ropes. As the illustrations show, each of the three stands carries four idlers, making a total of twelve to be accelerated or slowed down with the corresponding motion of the hoists. The idlers now used are of cast iron, with 22½-in. tread diameter, and weigh 200 lb. apiece. Formerly they had plain bearings, but all except two now have roller bearings. Mr. Stewart has been experimenting with new designs in an effort to decrease the weight. One of the idler sheaves now used and two of the experimental ones are shown in a cut. The latter are considerably lighter, but are not yet light enough. Mr. Stewart hopes to get the weight down to 50 lb. or less. To make a wheel weighing under 50 lb. will not be expensive, he thinks, the bearing costing about $10 and the tire $4. The bearing includes the outer race and rollers, the inner race being the shaft. The diameter of the bearing will be about 5 in., that of the hub around it 6 in.; and to the ends of the hub will be bolted 8-in. flanges. To these, in turn, will be bolted the side plates of the wheel. The tread will be 22½ in. in diameter, as in the present wheel. One of the wheels (shown herewith) already developed, and still too heavy,



Looking toward the No. 5 shaft along the main trestle from which the single-leg stocking trestles branch off to either side. In the foreground is one of remote-controlled larries.



Another view of 165-ft. No. 5 shafthouse. Top of mine-office and change-house building in lower left corner.

embodies an ordinary auto disk wheel (Budd Wheel Company, Detroit), with a solid rubber tire developed by Calumet & Hecla. It has been found that fabric cannot be used, but that the rubber must be solid.

The accompanying pictures show the system of single-leg stocking trestles with the central double-track line, and one of the 16-ton larries which convey the ore to stock. These cars take their current from an overhead rail and are remote-controlled from the shafthouse. The system is able to stock the entire output during the winter months. Floodlights on the side of the shafthouse furnish adequate lighting at night.

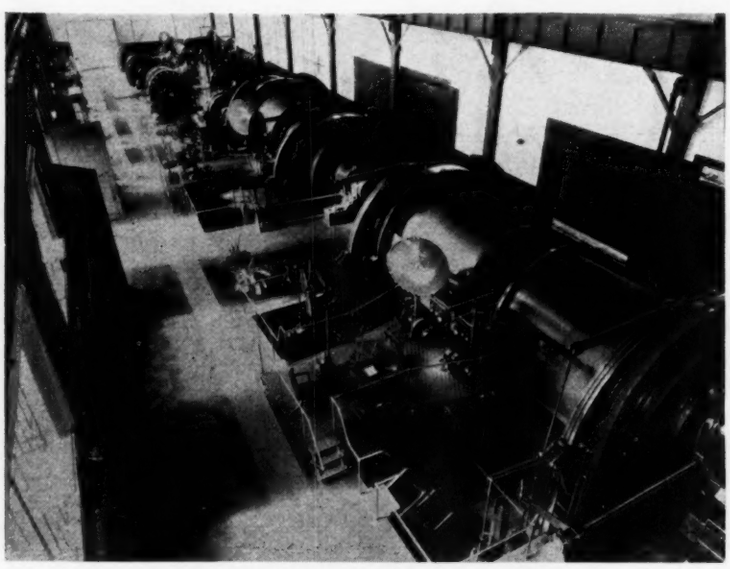
The illustration above shows, at the extreme left and just over the track, the top of the building housing the mine office and the change house. This being depressed below the level of the ground at the shaft, it is connected with the shaft by a tunnel through which the shift passes on entering or leaving the mine.

In the shops, among the matters of interest noted, some of which have already been mentioned, two items of practice drew attention. One was the sharpening of auger bits on an I-R 50 sharpener. Formerly these were sharpened by hand and about 25 were done per hour. At the time of my visit, this figure had been raised to 35 and was expected to go much higher. Special dies are used for cutting, shaping, and upsetting. The special shaping die gives the twist in the bit which is so necessary if the bit is to work the dirt outward. This die was made by first making a plaster cast of a properly shaped bit and then casting the die around it. The die is then cleaned out with a small emery wheel, to remove the plaster. The operation of sharpening consists of straightening and upsetting (first heat), and sharpening and shaping. The sharpening is done by shearing in two heats, and the shaping follows.

The other practice referred to is the method developed for making mine ladders. Formerly the rungs were made of ½-in. pipe. Now, most of the rungs used in a ladder—all except four in a 16-ft. ladder—are solid and made of ¾-in. round iron, 15 in. long over all, with a collar forged 2 in. from each end, so that the outside edges of the collars are 11 in. apart. The rungs are spaced 1 ft. apart (centers), the first being 6 in. from the top. The four remaining rungs (in a 16-ft. ladder) are of ½-in. pipe, each holding a ½-in. bolt. To house the ends of the pipe a 1-in. hole is bored on the inside face of each 2x4-in. side piece. Thus the assembling of a ladder is rather simpler than before.

Underground, as in all Iron Country mines, scraping is extensively practiced. In Duluth, the opinion had been expressed to me, regarding the seemingly steady increase in the size of scrapers, that the industry had already seen the maximum in this direction and would now witness a gradual return on the part of operators to scrapers of smaller size, which they would use more efficiently. With this opinion Mr. Stewart did not agree. He was boldly for bigger and better scrapers and hoists, and, in addition, for a.c. operation. The latter would necessitate two circuits but would lessen the cost of maintenance. Mr. Dick said the trend seemed to be toward higher speed in scraping, but that this was not important at the Montreal, because the mucking period was a relatively small part of the cycle. The 20-hp. hoist was giving 300 to 325 ft. per minute. The new Sullivan hoist was of similar design, but had a different motor speed and a different gearing ratio. It was giving about 1,750 r.p.m., compared with 1,150 for the older. Higher speed had hitherto been accomplished by brush trouble, but this was said to have been overcome.

Scraping is used in this mine in the loading drifts to transfer the ore from the raises to the cars in the haulage crosscuts, the ore being allowed to run freely from the raises into the drift for transfer. This practice is liked for several reasons. A considerable amount of sticky ore is produced, which would be likely to pack in chutes. Sometimes, said my guide, he had seen men working from above and below with an air blowpipe to get ore to run in chutes. Moreover, if haulage be interrupted, the ore can be spread out along the bottom of the loading (transfer) drift, the latter being thus used for storage. A third reason is that if the timber in the loading drift starts to crush, work can be continued longer with the scraper than with the car before retimbering is necessary. That is to say, for the car a larger opening must be maintained. Still another reason favoring the use of scrapers, and an important one, is that by this practice the management has eliminated all transportation accidents at chutes. When using cars, flying



Another view of the hoists and compressors at the No. 5 shaft, taken from traveling crane

chunks of ore and broken fingers were common. And a final reason is that the use of scrapers has trebled the tons per man engaged in ore transportation since the days of the chute. The distance scraped in the loading drift reaches 150 ft. on either side of the haulage crosscut. The latter is 4 ft. below the drift.

The company builds its own slides, as well as the slide car referred to in Mr. Schaus' paper. Mucking with the large 320-cu.ft. car in a single-track drift in slates the miners have handled five cars, or 1,600 cu.ft. of rock, in 1½ hr. Rock handled is customarily expressed thus in terms of cubic feet, and ore in tons. The trouble previously had with scraping in heading work had lain in the fact that it was necessary to move a single mine car at a time. So the company developed the mammoth car used. This must be moved by a mine locomotive as required.

To provide light in the loading drifts a Westinghouse floodlight is mounted above and back of the scraper hoist and gives ample illumination. In the sublevels the method of lighting is to use a 50-watt Mazda lamp with an ordinary reflector and a rubber socket on an extension made of rubber-covered conductor cord. The management, I was told, likes the floodlight better than extension cords. Similar rubber-covered conductor is used also to connect the motor on the slide car to the trolley wire, and some of the trolley locomotives are equipped with a reel of it, the same size cord being used for all purposes.

In connection with the blasting practice followed, the method of making the tamping cartridges used is of some interest. Clay sent underground in the fall before it has a chance to freeze is the material used. To form the cartridge, a tool resembling a pair of ice tongs, but having, instead of pick points, the halves of a hollow metal cylinder, split lengthwise, is used. The inside of this cylinder is of the dimensions of the cartridge to be formed, about the size of a stick of powder. Half a sheet of lining paper taken from a powder box is laid on the clay, and then, with a quick jab, paper and a cylinder of clay are picked up with the tongs and the cartridge is formed. The sheet of lining paper is just large enough for two such cartridges. To tear it in two, in the way that permits best rolling, another special tool resembling a plasterer's float is used. These dummy cartridges are made up by the magazine man underground.

Another rather unusual practice is the use of small compressed-air operated whistles at the foot of raises. Each whistle is connected with the top of the raise with a flexible wire cable. The miner at the top signals to his partner below by blowing the whistle.

Natural ventilation provides sufficient circulation through the mine, according to the Bureau's paper. Since this appeared, however, a Jeffrey propeller fan of 60,000 cu.ft. capacity at 2 in. of water has been installed. This fan has five airplane-type metal propellers, each 5 ft. 6 in. long from tip to tip, mounted on a single shaft, which revolves in ball bearings. Its operation requires 25 hp., 5 hp. for each propeller. The motor is direct-connected to the shaft. The propellers are enclosed in a cylindrical housing, 6 ft. 6 in. in diameter and 4 ft. long. When delivering 35,000 cu. ft. of air per minute, the pressure is 2.5 in. of water; 60,000 cu.ft., 2 in. (as previously stated); and 75,000 cu.ft. 1½ in. When blowing 55,000 cu.ft. or over, the fan develops a mechanical efficiency of 70-75 per cent. For ventilating development headings or wherever tubing is required, galvanized iron tubing, of about 24 in. diameter, is made up in the company's shops.

The pumping station on the 27th or 2,000 ft. level, already referred to, is of handsome proportions. The large sump is cleaned at intervals of a year or more by plugging in a small scraper hoist on the side of the drift opposite the end of the sump and scraping the settled material out. A slide is kept in the end for this purpose.

To keep the 200 rocker-dump cars, used for main haulage, in good condition, four men are steadily employed.

Guniting is freely used wherever it seems desirable. In the 27th level station, trouble was had with the roof on account of several faults. To remedy this condition, the back was first covered with paving reinforcement, approximately described as consisting of ¼ to ⅜-in. rods in 3- or 4-in. squares. This was bolted to the roof with eyebolts having an expansion end, and on top of it seven coats of gunite were applied. No further trouble has been experienced. On the first, or main, sublevel above the 2,900 level, now under development, ground has been cut out for a powder magazine, and gunited, and then painted red to a point about 4 ft. high and above that gray.

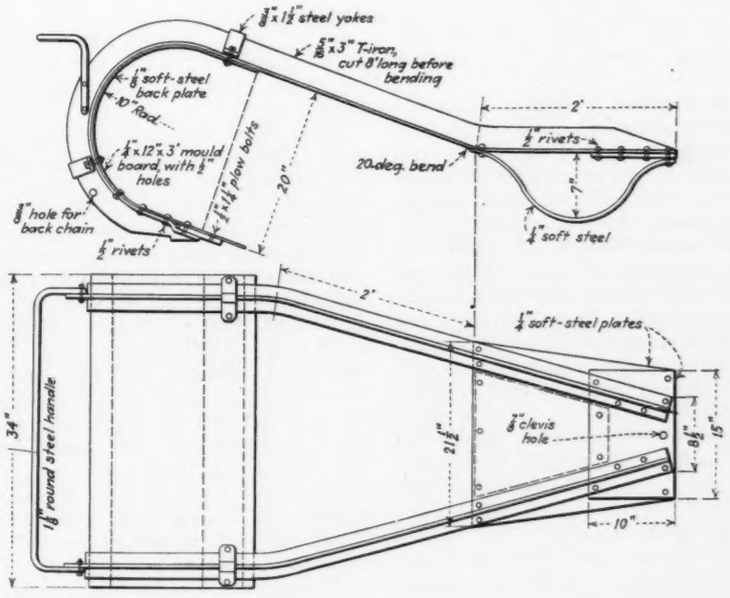
An item of geological interest was noted on this level (2,900) in the gunited haulageway. Although no mining has been done below this point as yet, a noticeable slip downward and to the west and visible in both walls has taken place. It shows also in the gunite (thereby demonstrating, as the learned geologist would say, that it is post-gunite).

As a safety measure along the main haulageways, a round is drilled and shot in the side of the drift every hundred feet. This is indicated by a blue light overhead and affords a safe place in which to stand when trains are passing.

■ ■

Underground Scraper Design

THE scrapers used in the Sixteen to One mine, in the Alleghany district of California, are 34 in. wide, to fit the skip. Design of the scrapers, which was developed by H. Kinkel, include a replaceable plow-steel blade and the use of T-irons for the principal members. Details of construction are presented in the line-cut drawing which appears below.



Summarizing Consolidated Mining & Smelting's Activities

George J. Young
Associate Editor

Last of a series of five articles on British Columbia's greatest mining enterprise

IN THE four articles that have gone before, technical data have been given of the mining and metallurgical practice of the Consolidated Mining & Smelting Company of Canada, Ltd., at its British Columbia properties. In concluding this series, a statistical review of the scope of this company's work will be given and its history will be traced briefly, pointing out the fundamental considerations that have been kept in mind by its officials in building up one of the great mining and metallurgical enterprises.

Production of Consolidated amounted in 1930 to 152,000 tons of lead, 120,000 tons of zinc, 7,000 tons of copper, 228 tons of cadmium, 7,000,000 oz. of silver, 26,000 oz. of gold, and, in addition, considerable sulphuric acid, some bismuth, and a small quantity of antimony. The company's principal reduction plant is at Trail, B. C., and its chief mine and concentrating plant are at Kimberley, 200 miles or so away, but in the same province. The production represents a consistent growth, which combines technical skill and business acumen of high quality.

The company was incorporated in 1905 in Canada as the Canadian Consolidated Mines, Ltd. Its name was changed to the present form in 1906. The original company was formed to take over the War Eagle Consolidated Mining & Development Company, the Centre Star Mining Company, the St. Eugene Consolidated Mining Company, the Rossland Power Company, and the Trail smelter. In 1916 the company acquired control of the West Kootenay Power & Light Company. The dominating financial influence is the Canadian Pacific Railway.

Rossland mines were the company's most important mines at the start, but with the developing of the electrolytic zinc process, in which the company pioneered, the Sullivan mine became the important ore source after 1915. Rossland mines were worked and supplied a small amount of ore to the end of 1928, after which they were practically abandoned. The total ore from this source amounted to 5,439,821 tons. St. Eugene mine supplied 1,026,435 tons of lead-zinc ore, and until recently its tailings, aggregating 524,354 tons, were worked. During 1930, apart from custom business, the metallic ore treated was derived principally from the Sullivan mine, only two other mines contributing small amounts. The Oliver property supplied 430 tons of silica and the Star phosphate claims contributed

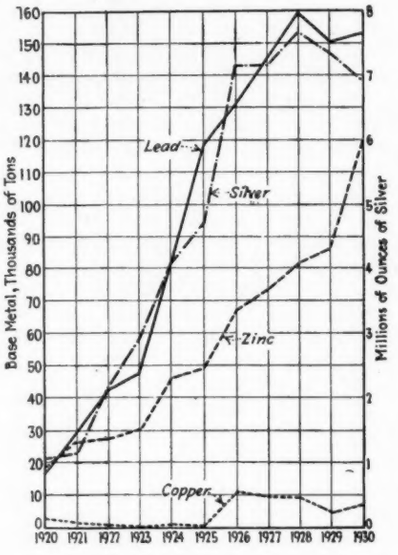


Fig. 1—Production of Consolidated in the last ten years

1,376 tons of phosphate rock. Sullivan mine produced 1,911,000 tons of milling ore and 13,000 tons of lead ore.

Aggregate ore production from the Sullivan mine to the end of 1930 was 12,000,000 tons. Totals from other company mines to the same date were about 7,900,000 tons of ore, which includes the Rossland production of more than 5,400,000 tons. Twenty mines, including the Rossland group as one, produced this total, and of these only four produced in 1930.

Apart from the Sullivan, the company's older mines appear to be pretty well worked out. All of the mines produced to the end of 1930 close to 20,000,000 tons of ore, both of mill and shipping grade and including some concentrates. Total metals produced were 1,345,000 tons of lead, 643,000 tons of zinc, 92,000 tons of copper, 83,662,000 oz. of silver, 2,229,000 oz. of gold, and 860 tons of cadmium. The time interval involved in this production is 36 years. Fig. 1 shows that the great increase in metal production of the Consolidated was in the last ten years.

The Trail plant is also a custom smelter, and during 1930 it purchased $4,063,125 worth of custom ore, bullion, and copper. During the period 1920 to 1930, inclusive, custom ore purchases totaled $27,290,304. Part of this ore was derived from the United States, but most of it came from British Columbia.

Properly to visualize the present position of Consolidated, some comparisons are necessary. World production of lead in 1930 was 1,835,000 tons. Consolidated's production was over 8 per cent of that. World zinc production in 1930 was 1,555,000 tons, of which Consolidated produced 7.7 per cent. Of the lead-producing countries, the lead production of this company exceeds the production of Spain, Germany, and Burma, India, and is exceeded by that of the United States, Australia, and Mexico. Only one of the United States —Missouri—exceeds its production. Of zinc-producing countries, the United States, Belgium (from ore imports), and Upper Silesia (Poland) are probably the only countries exceeding the zinc production of this single company. In the United States, no one state equaled Consolidated's zinc production last year.

The great lead-zinc mines of the world are the Sullivan, the Bawdwin, the Broken Hills group (Australia), the Poland-Silesia group, and now Mount Isa may also be included.

An annual metal production of about 280,000 tons places the Consolidated company among the world's great metal producers. The fact that most of this is derived from the Sullivan mine, at Kimberley, establishes this mine among the most notable lead-zinc-silver deposits.

On Oct. 4, 1915, Consolidated started a hydrometallurgical plant for the electrolytic recovery of zinc. The event marks the beginning of a fifteen-year period of progressive development. Production of the Sullivan mine in 1916 was 91,130 tons. At the time, selective mining was practiced and a zinc ore approximating 25 per cent zinc and 11 per cent lead, and a lead ore containing 14 per cent lead and 12 per cent zinc, were shipped to Trail. One was treated in the zinc plant and the other smelted in lead blast furnaces, which also handled the lead-bearing residues of the zinc plant. This treatment scheme was supplemented by milling, and an active campaign of research was begun, having for its object the concentration of the

Sullivan ores. The result of the research was the adoption of selective flotation and the construction of the Kimberley concentrator, which had an initial capacity of 3,000 tons per day. Its metallurgical results were decisive. The iron sulphide plus a low percentage of gangue constituents was largely eliminated. An approximate ratio of

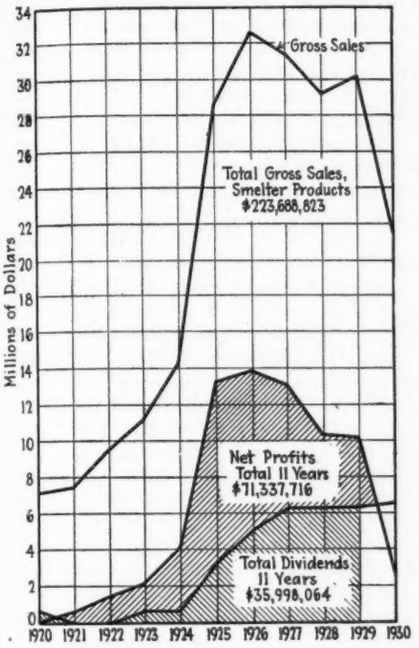

Millions of Dollars
Gross Sales
Total Gross Sales, Smelter Products $223,688,823
Net Profits Total 11 Years $71,337,716
Total Dividends 11 Years $35,998,064
1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930

Fig. 2—Gross sales, net profits, and dividends

concentration of 3 to 1 resulted in the elimination of almost 70 per cent of the ore weight and the production of high-grade zinc and lead concentrates.

Coincident with the milling program outlined in the foregoing, the zinc plant was doubled in capacity and the lead refinery increased to 325 tons per day. In 1925, the concentrator was enlarged to 4,000 tons, and increased zinc plant capacity followed. In 1929, the concentractor was enlarged to 6,000 tons' daily capacity. Zinc-plant capacity was increased to 300 tons. Mine facilities as well as accessory facilities at the Trail plants were increased to handle these additional tonnages. One of the dominating motives of this expansion in milling capacity was the desire to bring capacity up to the position where lower-grade ores could be handled profitably, thus providing for a more even mining of the large deposit, which theretofore had been selectively mined. With the present capacity, ore is now taken from a larger number of stopes, and the higher-grade stopes are less heavily drawn upon.

For the time being, the company's milling program has reached a static position at 6,000 tons per day, and attention will now be directed to the improvement of different parts of the plants at Kimberley and at Trail. One of the major improvements at Trail was the construction of a zinc-fuming plant for the treatment of the lead blast-furnace slags. Whatever zinc escaped the hydrometallurgical plant in the residues, together with the zinc in the lead ore and lead concentrate, was eliminated in the lead blast-furnace slag and smelter gases. About 85 per cent of this zinc is now being retrieved in the form of zinc oxide along with the lead formerly lost in the slag. This zinc-lead fume is treated in a separate hydrometallurgical plant, where the zinc is dissolved in sulphuric acid and the lead-bearing residue returned to the blast-furnace circuit. The dissolved zinc is electrolytically deposited.

Along with the increase in smelting capacity in 1924, and in anticipation of changed conditions resulting therefrom, a new zinc roaster stack 400 ft. high and 21 ft. in diameter, of brick-lined concrete construction, was built, and in 1925 a similar stack, 400 ft. high and 25 ft. in diameter, was provided for the lead smelter. Accessory flues and Cottrells were included in this construction, and the stacks were considered high enough to diffuse the increased volume of sulphur dioxide resulting from the larger tonnages handled. After Mr. T. A. Rickard visited Trail in 1916 he wrote: "The smelter is not bothered by 'smoke suits,' the Consolidated company having purchased the adjacent land to avoid this very trouble. Now that the operations of the smelter support a community of increasing size and create a market for agricultural products, the farmers are buying back the land under agreements to which a smoke clause is attached."

But when I visited Trail in 1922 the manager, Mr. Blaylock, was in the throes of settling up local "smoke suits." Although Consolidated has installed the most modern facilities in stacks, flues, dust chambers, and Cottrell treaters, the topography at Trail imposes natural disadvantages. The narrow Columbia River valley continues to the south across the international boundary 7 miles' distance. Twenty miles south is Northport, and still further, 40 miles, is Marcus, where the Columbia River valley widens. American farmers and horticulturists have claimed damages from smelter smoke in the valley south of the international line and almost as far as Marcus. Recently the International Joint Commission has been delving into the subject, and awarded $350,000 to the farmers, a decision that satisfied neither the farmers nor the company, so it is being appealed. With this we are not especially concerned, but we may note the steps that are being taken by Consolidated to lessen the amount of effluent sulphur dioxide, and what it is going to do with this gas.

I do not know of a smelting organization that has been more active in applying whatever new thought has developed in stack, flue, and treater equipment, toward lessening smelter-smoke difficulties, than the one at Trail. Apart from this, great progress has been made in reducing the ratio of sulphur to metal content in the concentrates delivered at the smelter. In 1916, crude ore was shipped to Trail. The accessory pyrrhotite and pyrite necessarily accompanied the zinc and lead to the roasters, and the sulphur had to be oxidized and passed into the atmosphere as sulphur dioxide. Concentration reduced the ratio of sulphur to metal content, and selective flotation finally succeeded in eliminating a great proportion of the iron sulphide. Obviously, the sulphur locked to the lead and to the zinc could not be separated mechanically, but the greater proportion of all of the other sulphur is sent to the tailing pond at the Kimberley concentractor. Thus the company sent no more sulphur to Trail than could be avoided. Its dust and fume equipment removed suspensions from the smelter gases and its stacks discharged at such a height (400 ft.) as to warrant the assumption that diffusion would reduce the concentration of sulphur dioxide sufficiently to result in comparatively small harm outside of a radius of 6 to 10 mines. Topography, however, concentrated the gas diffusion in the southerly direction, and presumably local gas concentrations extended beyond the limits mentioned, and persisted sufficiently to cause some damage. Extension of the zone of damage followed upon the increase in plant capacity. The reduction of the

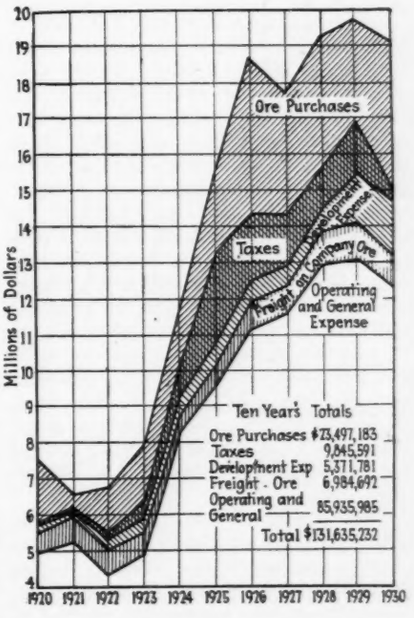


Fig. 3—Expenses for eleven years

amount of liberated sulphur dioxide was the obvious remedy, but this would have required either less capacity or the utilization of part of the sulphur dioxide in some way.

The company directed its research to reducing sulphur dioxide to sulphur and is continuing this work. Conversion of sulphur dioxide to sulphuric acid obviously necessitated the discovery of

some use to which the sulphuric acid could be put. A contact acid plant of 35 tons' capacity per day was erected, displacing a small chamber-acid plant which supplied the sulphuric acid requirements of the zinc plant and the refineries. The practicability of the manufacture of concentrated fertilizers at the plant was also investigated. Other kinds of fertilizers seemed to be out of the question on account of the freight rates to prospective markets. The possibilities of developing a market for concentrated fertilizers also were investigated, and after several years of systematic experimentation in the prairie provinces results were obtained which showed that such fertilizers would be of economic advantage to the farmers of that region. Whereupon the company decided to solve its smoke troubles by the erection of sulphuric acid plants, which with the plant already in operation would give it an outturn of 380 tons of sulphuric acid per day and which would reduce the amount of liberated sulphur dioxide by about 38 per cent.

Erection of a fertilizer plant for the manufacture of concentrated fertilizers is being completed. Thus the new work has to do with smelter byproducts, as in the recovery of zinc contained in the smelter slag. The new sulphuric acid and the fertilizer units, involving an investment of about $10,000,000, represent the establishment of a huge chemical industry that is destined, in my opinion, to have far-reaching effects. Furthermore, the program reflects the stamina and courage of the management and directorate of this company, for the field is new, the market is undeveloped, and the undertaking involves a different sort of merchandising from that involved in the marketing of metals. But the company has proved its ability to pioneer metallurgically and to market its products. It has sent its technical men to Europe to study the latest developments in ammonia synthesis and in superphosphate technology and is bringing the best of these modern processes to its new enterprise. A division of agricultural research has been established and its future position, in this field, though in the lap of the gods to some extent, is headed in a direction defined by an intelligent preview of a difficult situation.

The great advance in production, sales, profits, and dividends, as well as plant expansion of the company, began in 1924 and continued during the last seven years, the culminating feature of expansion being the construction of the fertilizer plant in 1930. Fig. 2 gives graphically gross sales of smelter products, net profits, and dividends for the period beginning with 1920. Fig. 3 is the graphic presentation of expenditures and includes operating and general expenses, freight cost between Kimberley and Trail, development expense, taxes, and ore purchases. The total of these expenditures has recently approached $20,000,000. This in itself indicates the tremendous economic importance of the company's operations to British Columbia and to Canada.

Fig. 4 indicates the amounts involved in plant expenditures and purchases of mining property. The total of these expenditures was $9,280,010 in 1930, of which plant accounted for $6,365,736 and property $2,914,274, making the total money outgo for that year, including operating, almost $22,000,000. The outgo of 1930 and of the preceding five years indicates that the company is

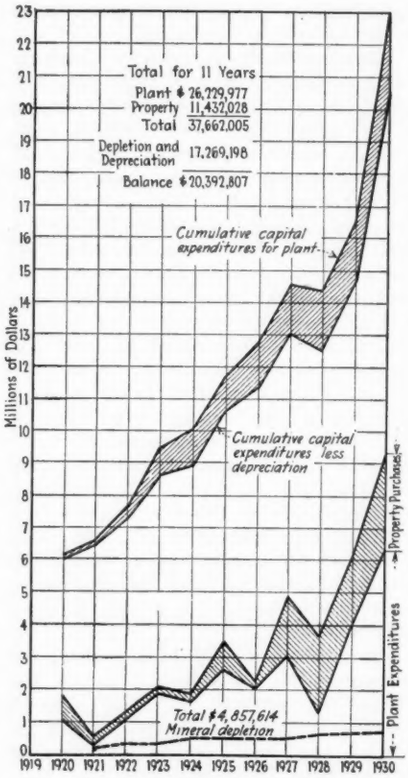


Fig. 4—Expenditures for plant and purchase of properties

engaged upon a constructive program which has for its objective the placing of its plants upon the most efficient basis and the extension of its mining properties to include additional ore reserves beyond those contained in the great Sullivan mine.

Apart from expansions at Trail and Kimberley, the outstanding objective of the company is its search for new mines. Operation, exploration, and examination work are managed by W. M. Archibald, vice-president in charge of mines, who has an operating staff of nineteen engineers and assistants and an exploration and mine examination force of 27 engineers and assistants. An air service was organized early in 1929. The company has its own corps of trained pilots. Flying equipment is used in the transportation of men and supplies to properties under option in northern Saskatchewan, Manitoba, and Ontario, and provides for the transportation needs of examining engineers in the same localities. In 1930, total hours flown was 3,921, covering 325,162 miles. Equipment includes Curtiss-Robin monoplanes, Gypsy Moth seaplanes, a Puss Moth monoplane, and Fairchild 71's.

Results of the 1929 and 1930 exploration campaigns are indicated in the company's annual reports. Three methods are followed: (1) Purchasing of a controlling or minority interest in existing companies, the money to be expended in exploration; (2) optioning properties; (3) by prospecting agreements and prospecting parties. Much underground work, including diamond drilling, is done at the properties under option. Apparently no good showing of mineralization is allowed to escape systematic drilling or underground exploration.

Every year numerous options are taken for properties on which subsequent work is done, and the company's own engineers are in a large number of fields. Even in the unfavorable year 1930, 452 properties were reported on, 188 of which were in British Columbia, 63 in Ontario, 50 in Manitoba, 15 in Saskatchewan, 43 in Quebec, 12 in Nova Scotia, 4 in New Brunswick, 13 in the Yukon and Northwest Territories, 5 in Newfoundland, 43 in the United States and Alaska, and 16 in South Africa. But as a result, in part, of unfavorable metal prices and the future outlook, tentative options were taken on only 16 properties. On half of these, further sampling and preliminary surface work resulated in their abandonment; on six others diamond drilling or underground devlopment was carried on before abandonment. Two of the options are being continued.

The finding of commercial orebodies is probably not as difficult as winning a "hole in one," but it is difficult enough, as mining experience has shown. Still, much can be expected of an exploration organization managed by experienced mining men and with ample funds and facilities at its command.

The company has an 11 per cent interest in the Copper Cliff copper refinery of Ontario Refining Company, Ltd., where all of its copper refining is done.

The great volume of metals produced by Consolidated necessarily involves special selling arrangements. For Canada, a sales office in Montreal is maintained. In 1924 an interest in A. Cameron & Company, Ltd., was acquired, which company represents the Consoliated in the Orient. In 1926, an interest was acquired in Henry Gardner & Company, Ltd., European representatives of the company. The last-named company has an arrangement with the British Metal Corporation, Ltd., for an association in selling metals, functioning through a holding company, the Amalgamated Metals Corporation, Ltd. Two selling organizations respectively serve the Oriental and the European countries.

Trail is 500 miles from Vancouver and Kimberley is 200 miles from Trail.

Connection hitherto between the two points has been by rail to Kootenay Landing, by boat between Kootenay Landing and Proctor, and thence by rail to Trail. But the Canadian Pacific Railway has constructed a connecting link along Kootenay Lake between Proctor and Kootenay Landing, and this now gives an all-rail route between mine and smelter.

At Fernie is an important coal field that supplies Trail with coal and coke. At Bonnington Falls on the Kootenay River, the West Kootenay Power & Light Company has two power plants, with generator capacity totaling 82,500 kva. and hydro turbines of 98,000 hp.; and at South Slocan is generator capacity of 52,500 kva. and hydro turbines of 75,000 hp., or a total of 173,000 hp.

The power company is owned by Consolidated. The greater part of its power is delivered to and used at the Trail plant. As the transmission distance is only 35 miles, and the power plants represent an asset valuation of $11,888,074, the cost of power is comparatively low. Cheap power has made Trail, with its huge electrolytic refineries, possible. Likewise, it has made possible the exploitation of the ores of the Sullivan mine.

Fig. 5 shows the increase in power supplied by the West Kootenay plants during the ten-year period. The increase from 1924 was absorbed almost wholly by the Trail plants. At Kimberley, power is supplied by the East Kootenay Power Company, which has hydro plants at Bull River and Elko. Both plants have generator capacity of 23,000 kva., hydro turbines of 22,200 hp., and steam turbines of 6,666 hp. Consolidated has an auxiliary steam power plant at its concentrator near Kimberley.

The component parts of this great enterprise are a huge mineral deposit, cheap power, and both coal and coke near by. A concentration of exploitable natural resources thus makes it possible for the company to maintain about 5,000 employees and by its payroll of some $8,000,000 per annum to support the towns of Trail, Rossland, and Kimberley, and less directly to stimulate business over a wide region.

Its freight payments aggregate close to $4,000,000 per annum and it is a large purchaser of materials and supplies of diverse kinds. Its warehouse at Tadanac maintains an average stock representing $850,000 in value, the monthly turnover of which is $240,000. The importance of mining in upbuilding the prosperity of its surrounding region is well illustrated by this British Columbia enterprise.

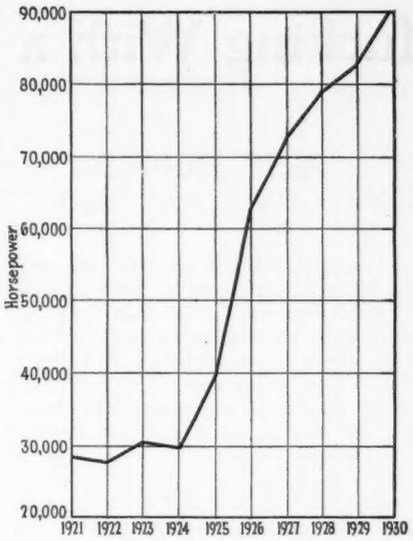


Fig. 5—Increase in power supply in ten-year period

Consolidated has adopted a broad attitude in the treatment of its employees and in the development of the communities in which the men live. Labor turnover is very low. A safety program under the direction of trained safety men last year reduced the shifts lost due to accidents by 17 per cent over the record for 1929, and 42 per cent over that of 1927. Safe operating conditions receive detailed attention and change rooms and accommodations for workers are being improved. An employee representation organization consisting of 30 employees elected from various departments assists in running the plant efficiently and fairly.

A variable wage system based upon an average base price for lead and zinc at £17 per long ton in London gives a bonus of 10c. for each £1 advance above the base and a corresponding deduction for a decline. A recent concession by the company reduced the rate of deduction to 5c. for each pound sterling decline between £24 10s. and the base. In addition, an efficiency bonus has been established, based upon improvement in any one department over an average performance for the six months previous to the establishment of the bonus. An annual bonus of $50 is paid to each married man and $25 to each single employee.

Assurance of a square deal is provided by an "open-transfer" system. Medical attention and hospitalization are provided by membership in the medical organization at a cost of $1.80 per month, besides which the company contributes 30c. The recipient and his dependents receive medical and hospital treatment and the company pays half the cost of all specialist work.

Consolidated issues one share of its stock to each employee of three years' standing. It also maintains a group-insurance plan by which each employee receives a straight life insurance of $500 after being employed for three months, and this automatically increases by $100 each six months until a $1,500 maximum is reached. Each employee has the privilege of taking out an additional $1,000 at the group rate. The total of the insurance now in force is about $12,000,000.

A pension system is in operation which provides for retirement payments at the age of 60 and after fifteen years or more of employment. The company also assists its employees in acquiring homes. More than 600 homes have been completed on this plan, and the housing fund of the company now totals $750,000. Employees themselves maintain benevolent societies.

A personnel department under C. W. Guillaume supervises activities in which the company has a direct interest. I had the pleasure of a chat with Mr. Guillaume, and from him gathered an idea of the completeness of the company's efforts to make the work of its employees remunerative, safe, and healthful, and to encourage them to provide for the future.

Coal and coke for Africa copper mines. A heavily laden train leaving the Wankie Collieries, in Rhodesia

Shaft Mucking With a Scraper

A. H. Hubbell

EXTENSIVE as the practice of scraping has become for handling broken ore or rock in drift or stope, no instance has hitherto been recorded where it has been applied to mucking in a shaft. The first application of the scraper to this work, and with successful results, is to be credited to the Copper Range Company, at Painesdale, Mich., which is using it in the course of deepening the No. 3 and 4 shafts of the Champion mine. Recently through the courtesy of Mr. W. H. Schacht, president of the company, and Mr. Albert Mendelsohn, general superintendent, I was privileged to witness this work on a hurried trip to the bottom of No. 4 shaft, then approximately 3,800 ft. deep. This shaft is sunk on 70 deg. and is 10x23 ft. in cross-section. Scraping is conducted in the manner one would expect, with the hoist overhead on the timbers, about 50 ft. above the bottom, and the pull and tail ropes passing down to and around their respective blocks in the 10-ft. ends of the shaft, at some convenient height above the bottom, and thence to the scraper in the 23-ft. space between. The application seems very simple, now that it has been made, and one wonders why it has not been tried before. This is commonly true of successful innovations, however. Scraping is scraping, wherever it is practiced, the nature of the operation not permitting any wide variations in the manner of conducting it. In the present instance it has been adapted to shaft work principally by modifying the drilling round, as will be described, and by devising a special slide, delivering to the bucket.

Sinking is conducted under a 10-ft. rock pentice. The amount of water made is small and is removed with an air pump. For hoisting men, rock, and supplies, a 1,600-lb. bucket is used, this being in the left end of the shaft (looking down from the footwall side). Regular shaft sets are carried down to within approximately 10 ft. of the bottom. The bucket is lowered and hoisted in a vertical position in the inclined shaft with the aid of a carriage which deflects the rope and rides on a 10-in. I-beam as on a rail. This beam is clamped to the hanging-wall plates. The hoist rope passes through a block on the carriage to the bucket hanging vertically beneath. On being lowered, the carriage goes as far as the end of the I-beam, the bucket then continuing down vertically to the bottom. Conversely, on hoisting, bucket and rope move upward until the bucket picks up the carriage, which guides it up the shaft beneath the I-beam. Around the bottom rim of the bucket is a circular railing which functions in dumping, in a manner to be described.

To permit efficient scraping, the rock, on being blasted, must be thrown to the (right-hand) end of the shaft opposite that where the bucket must sit for loading. This is accomplished by using a drill round having an end-cut in the end where the muck is wanted, and by shooting the half of the round that includes the cut holes before the other half is shot. A 6-ft. round of 50 holes is drilled and 6 ft. is pulled. On shooting the first half, the greater part of the muck is piled up in the right-hand end as wanted. The rest of the holes are then shot, breaking to the free face so that the rock is thrown on the pile already made. Work is then resumed in the shaft, the bucket is set down in the bottom, and the special steel slide lowered. This slide is in two pieces, the slide proper—an apron of ½-in. plate covered with a ¼-in. wearing plate and flaring from 39 in. in width at the top to 5 ft. at the bottom, with a 10-in. upturned edge on each side to serve as a sideboard—and a hinged collar attached to the top of the slide and having a 2-ft. hole through which the muck may enter the bucket when the collar is rested on the latter. When the bucket is full, the collar is thrown back and stays in this position, a little past the vertical and resting on the slide.

To support the slide in its proper position, a miner's post is first set across the shaft horizontally from foot to hanging at the height desired and the slide rested on it with its lower end on the bottom or on the muck. The rock heaped up is then scraped into the bucket. When most of it has been scraped, the scraper is reversed end for end on its ropes, the slide moved aside, and the muck under the slide, with any that may have been thrown to the bucket end of the shaft, is scraped back to the cut end where the large pile stood. The scraper is now once more reversed to its original position, the slide and bucket are replaced, and this remaining pile of rock is scraped into the bucket, completing the scraping operation.

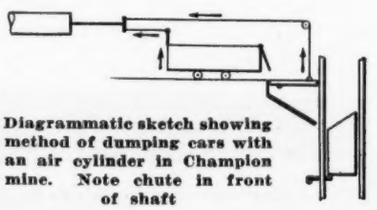
Scraping was being done, at the time of my visit, with a 30-in. hoe-type scraper and a 15-hp. double-drum electric hoist. Experiment had shown in the few weeks the work had been in progress that a 45-deg. angle was best for the scraper blade. The angle is changed by altering the angle of the bail.

To hold the blocks, holes are drilled laterally in the walls, as sinking progresses, wherever the drillers think they will be needed. Approximately, the practice is to drill three in each end wall—that is, one in each corner and one in the middle, at desirable vertical intervals, say about a round apart. The blocks are held by split eye-pins wedged in the holes. A ½-in. x 9 x 16 rope is used for both pull and tail.

For dumping, a special chute is used near the bucket hoist above the pentice. This has an arm projecting from it with a notch at the free end. To dump, the bucket is raised, the chute dropped under it, and the bucket lowered; the railing on its bottom catches on the bar and slides along and into the notch, and the bucket overturns into the chute, which discharges into a bin in the left end of the shaft just above the station landing. To get the rock from this bin into the skip in the shaft compartment to the right of the bin, a chute turned 90 deg. to the right and mounted on a truck that runs on a short track in front of the shaft and parallel with the wall plates, is used. This, when pulled into position below the bin chute, is just long enough to deflect the rock from the bin into a third chute below the track and directly in front of the skip compartment (see accompanying sketch), into which chute the mine cars dump to load the skip. This third chute ordinarily is covered by a hinged platform which may be raised by an overhead air cylinder for dumping either rock or ore.

Excellent work has been done with scraping in the Champion mine in driving the main level drifts, which are 8x13 ft. in size. For this work the company uses the Osana-type slide with a 40-in. hoe scraper and a 15-hp. Sullivan double-drum hoist (electric), and scrapes into 5-ton cars. About twelve scraper loads are required to fill a car, or 830 lb. per load. The efficiency and other results obtained depend to a large extent on the organization of the work. Four miners and two helpers are used on each of two shifts, with four I-R RA72 machines. This crew drills, blasts, mucks, trams, dumps, lays track, and, in short, does everything except string trolley wire. It advances the 8x13-ft. drift 14½ ft. in 24 hr., with a center V-cut round of 34 6-ft. holes.

All men employed underground are required to wear safety hats and safety shoes and to be provided with a pair of goggles. These are sold to the men, who are allowed three months to pay for them.



Diagrammatic sketch showing method of dumping cars with an air cylinder in Champion mine. Note chute in front of shaft

Comment . . . Criticism . . . Personal Notes

Mining Practices Ten Years Hence

To the Editor of "E.&M.J.":

Recently a prominent architect and city planner, Norman Bel Geddes, announced what he believes to be the ten principal changes that will affect our living conditions within the next decade; others have followed, each in his line of industry, to depict their views of the future in that which more closely touches them. I have outlined what seem to me as the ten most probable important changes or developments that will occur in the mining industry before 1941, offered somewhat as a prophecy, somewhat as deductions. I do not suggest that the order of tabulation represents the importance of the changes.

Hoisting of Men and Ore—Hoists will be automatic wherever possible, which means in almost every permanent installation. The fundamentals of this have already been worked out on many of our larger installations, and only the question of cost prevents more rapid adoption. One might even imagine a shaft-sinking crew having direct control over the muck bucket, not dependent upon a hoistman they cannot see but who they hope is standing by to hoist away when the last hole is loaded. Installations of power accumulators, such as flywheel sets, will be prevalent, to overcome the old bugbear of "Power is off!" Hoistmen will all be licensed by the State.

Transportation—In many mines the ore car will have gone the way of the single-jack and long-handled shovel. All ore in stopes will either drop by gravity, or be slushed into chutes where it will drop into centrally located ore pockets that will connect with the hoisting shaft by conveyor belts. These conveyors will operate in either direction, bringing ore to the shaft and taking supplies into the interior workings.

Supporting Ground—Mine timbering methods will have undergone radical changes. It will no longer be permissible to timber or line a principal shaft with inflammable material. Guniting, steel or concrete sets, guides and ladders, and steel or concrete headframes will be part of the measures taken to insure safety to the shafts and workmen who make use of the same. All supports of principal passageways, ore pockets, or other semi-permanent constructions, will make use of a larger proportion of concrete or steel than at present. In effect, the tendency will be not to use timber if it can be avoided. In ore breaking, likewise, those methods that use less timber will be in vogue, which also applies to back-filling. Wherever it is still found necessary to use any system of mining that requires back-filling, provisions will be made to secure this filling from above, and distribute it by slushing, thereby doing away with the wheelbarrow and much of the shoveling of today. There is nothing new in this part of the work—the part that will be new is that it will have become universally used.

Drilling and Mucking—The present compressed-air hammer drill will have given away to a rotary boring machine, using bits tipped with one of the new alloys that are being developed to withstand abrasion. In softer ground use will be made of an adaptation of the traveling cutter similar to the coal-mining machine, but using the alloy-tipped steel bits. In driving a heading, or sinking a shaft in hard ground, the drills will be mounted on a carrier which will be a cross between those used in some of the long tunnels being driven today and the automatic boring machines developed in the automobile building industry. The round will be drilled to unvarying pattern, one driller controlling the operation of the entire machine. Mucking will be done by machine muckers. Where the space is limited or the amount of material small, slushing will be used, but in all headings or where there is a quantity of muck to move, power shovels, Link-Belt excavators, or similar machines will move the muck into chutes or onto conveyor belts. In shaft sinking, as soon as the round is shot a machine with a bucket line directed by a digging ladder similar to the California dredge will be lowered to position on one side, a skip to receive the discharge from the bucket line lowered to position on the other side, the round mucked out, the sides picked down, the next set lowered and blocked to place, guides extended, the drilling machine lowered to place and the next round drilled—the cycle being about as follows:

	Hours	Minutes
Round fired	0	0
Moving mucker and skip to position	..	30
Mucking	1	0
Placing next set and extending guides	1	0
Moving drill machine to position	..	30
Drilling, removing drill and loading holes	1	0
Total time of cycle	4	

The cycle in drifting will be three hours. Cycles will be independent of shifts, which will change "at the handles of the drills." The power will be electricity. Dusting will be eliminated. Either water used on drills will be sufficient or a vacuum dust collector will be part of each drill's equipment.

The Explosives—The use of dynamite underground will have become practically obsolete. Some method will have been discovered to keep the cartridge "alive" for as long as necessary, and L.O.X. or similar form of oxygen explosive will be customary. Firing will be electrically and by distant control.

Exploration—The engineer will direct exploration work in conjunction with the routine sampling for ore production. Full use will be made of geophysical methods of ore finding. In advance of ore breaking, a thorough examination will be made of the ground by scientific prospecting, perhaps confirmed by drilling, and the probable tonnage known, before expenditures are made for its extraction. "Dead-horse" crosscuts into barren ground will be unnecessary.

Ventilation and Lighting—Mine ventilation will receive close consideration. Aside from the purpose of giving air for breathing or gas dilution, the air will be cooled, somewhat as it now is in many moving-picture houses; and in the Far North, the reverse will take place and warmer air sent down. Ventilation will be controlled by a combination of thermostat and oxygen meter, that will automatically open and close valve doors on the air circuits. All mines will be better lighted, and the open-flame lamp will be obsolete. Electricity will be employed, both for permanent installations as well as for portable lights. Men working in groups will not use individual lights. A form of globe or tube will have been developed for use in gassy mines, which will not spark should the glass be broken. These tubes will receive power by wireless, and the light will be produced without heat.

Shaft Sinking and Drainage—Mine water will be less of a problem. All permanent installations for pumping will be automatic. Portable pumps such as sinkers will be constructed of one of the lighter alloys, and electric drive will be customary. In sinking against water, ample sized pilot holes will be put down by drilling, pumps installed therein, and the ground drained ahead of actual sinking. Circular shafts will be in common use. It is possible that excavating machines developed along the lines of a giant rotary oil rig will sink a shaft full size at one operation.

Superintendence—No railroader could comprehend any other way of selecting locomotive engineers aside from the long-tried methods that are used on all roads, but many mine superintendents today fail to comprehend that neither the young engineer just out of the classroom nor the tough guy that crimps his dynamite caps with his teeth is a fit candidate for leadership—at least without further instructions, experience, and trials. Some countries have even now provided by law that certificates of proficiency may be obtained only after experience and examinations have demonstrated ability and fitness, before trusting the lives of the run-of-mine workmen to their charge, and this will be the general custom. Safety first will be no novelty, but the usual thing. All parts of the mine will be in constant communication with the office through radio, both for receiving and sending messages.

Finances—Financing of new mines will be taken care of differently. No longer will it be necessary to raise money by selling stock to your wife's relations, or to tie up your mine with a larger mining company by a contract that eventually will put not only the control but also the profits

TO PREDICT is sometimes to advocate, sometimes to deplore. The prophet is not without honor. He usually starts many independent trains of thought. Mr. MacCoy's soothsayings, though inviting controversy in some details, are based on a varied and successful executive and technical experience.

of the mine out of your reach. Financing companies will operate somewhat along the lines of the building and loan companies' methods for supplying funds to the home builder that owns his land and needs help to build the house. These companies naturally will employ efficient help to determine the probabilities of success to the venture. Many will smile at this prediction, but our grandfathers would have snorted at the idea of a bank financing a contractor on a big construction job.

The foregoing are the ten changes or developments that most appeal to me, as most probable of realization. No one of them is a new idea; each has been thought of and within limits has been tried, but no one has become general in use. If the reader does not agree with the list, he can develop his own, and there will be no hard feeling in the matter.

If one really wants to check up on the prophecy, just clip this out, put it away with those shares of Jerome Junior that you thought were going to make you a second Morganfeller, and then in years to come, when you clear out the old trunk, preparatory to moving to the old men's home, take a look at it, and drop me a line.

FREDERICK MACCOY.

Berkeley, Calif.

W. A. RuKeyser has left New York City for Arizona and Canada.

A. J. Hoskin, recently editor of *Pit and Quarry,* has resumed private practice as a consulting mining engineer and geologist. His headquarters are at 68 N. Edgwood Avenue, LaGrange, Ill.

Dr. T. A. Rickard is the author of a treatise entitled "Man and Metals," which will be published in two volumes in October next by the Whittlesey House division of the McGraw-Hill Book Company.

E. J. Mehren, vice-president of the McGraw-Hill Publishing Company, has resigned to become president of the Portland Cement Association. Mr. Mehren was formerly editor of *Engineering News-Record.*

Jacques Aguillon and **Baron Etienne de Sigalas,** both prominent in French business and financial circles, have joined the board of directors of the Central Mining & Investment Corporation, Ltd. The corporation is now represented in France by the Crédit Lyonnais, 19 Boulevard des Italiens, Paris.

Dr. V. H. Gottschalk, senior physicist of the U. S. Bureau of Mines, has been appointed metallurgist of the U. S. Bureau of Mines station in Tucson, Ariz. He succeeds J. D. Sullivan, who resigned recently and is now with the Batelle Memorial Institute, Columbus, Ohio.

Clarence Thom has resigned as superintendent of mining and milling operations for Goldstone Mines, operating at Baker, Idaho, and has opened offices in the Lumbermen's Building, Portland, Ore. Mr. Thom, who was at one time with the U. S. Bureau of Mines, expects to devote most of his time to the development and financing of Northwestern mining properties.

McKinley W. Kreigh, who for the last several months has been engaged in studies and special research work at Seattle, Wash., in regard to state and local conditions affecting the natural-resource industries in the Pacific Northwest, has returned to Washington, D. C. to assist the Timber Conservation Board in assembling certain technical and statistical data for the reports of that board, particularly with reference to possible legislative recommendations.

John G. Barry, consulting mining geologist and engineer, of El Paso, Tex., has been appointed president of the Texas College of Mines and Metallurgy at El Paso by the Board of Regents of the University of Texas. This is the first time in the history of the College of Mines that the institution has had a president of its own. Although Mr. Barry has been actively engaged as a consulting mining geologist and engineer since leaving his position as chief geologist with American Smelting & Refining, in 1924, he previously taught, first in the geology department of the University of North Dakota, 1907-09, and later at the Massachusetts Institute of Technology, 1916-20, from which institute he graduated in the class of 1907. His work at the Massachusetts Institute of Technology was interrupted during the World War by service overseas, where he became a lieutenant colonel in the Chemical Warfare Service and was in charge of gas defence. Mr. Barry has already assumed the duties of president of the college, but will continue his consulting practice on a limited scale and as far as the interests of the college permit.

Jesse L. Maury, whose contribution in a recent issue of *Engineering and Mining Journal* on "Enlightened Labor Policies" will be recalled, has been granted one year's leave of absence from his duties as manager of the Broadwater Consolidated properties at Neihart, Mont., in order to be free to accept a special fellowship and to undergo training at the Massachusetts Institute of Technology, under the terms of a scholarship sponsored by Messrs. Lammot du Pont, Alfred P. Sloan, Jr., John R. Macomber, F. W. Fabyan, Charles A. Stone, and Charles Hayden. Mr. Maury is one of six graduates chosen out of a total of 3,500 who have graduated since 1925. The purpose of the fellowship, according to the New York *Times,* is to permit a small group of carefully selected young men of intellectual ability and outstanding personality to develop, by special professional training, their natural qualities of leadership, vision, and sound judgment. Each year for five years after the scholars enter, or re-enter, the business or industrial field, they will make a report of self-development to the sponsors of the fellowships.

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Among contributors to this issue:

Morris J. Elsing recently concluded a series of articles on mining methods. A biographical note was published in a former issue.

W. M. Goodwin, a graduate of Queen's University, Kingston, Ont., has specialized in exploration and development in the mining regions of eastern Canada, and in metallurgical researches the outcome of mineral discoveries. During recent years he has served as editor of *Canadian Mining Journal.*

V. M. Karmashov, a graduate of the Moscow Industrial Academy, has had an extensive practical experience as operator, mine foreman, superintendent, and general manager of Siberian gold properties. At present he is the representative in the United States of the United Non-Ferrous Metal Industries of the U.S.S.R., with headquarters in New York City.

Frederick MacCoy (Purdue and Columbia universities) has practiced his profession in various parts of the United States, Mexico and South America, as a consultant and as member of the staffs of United Verde, U. S. Smelting, Esperanza Mining, and San Rafael Mining. Until recently he acted as resident director in Mexico for San Rafael y Anexas.

D. C. Gilbert (Ohio State University, 1917), who contributed an article in the July 13 issue on "Mine Maps," has practiced his profession, underground and on the surface, in Alaska, Montana, and Arizona. He was awarded the President's Prize (A.I.M.E.) in 1921 for his paper on "Routine Mine Sampling." Mr. Gilbert since 1924 has occupied the post of geologist to the International Smelting Company, with headquarters at Salt Lake City, Utah.

W. O. Borcherdt joined the technical staff of New Jersey Zinc in 1905, following graduation from Stevens Institute of Technology and several years' experience at mining properties in the United States. He was superintendent of the Bertha Mineral Company, a subsidiary of the New Jersey Zinc, from 1906 until 1925, when he was made assistant general manager of mines for the parent company, with headquarters in New York. He is known principally for his metallurgical achievements, in which field he holds numerous process patents.

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Obituary

James B. Adair, formerly associated with mining in the Pacific Northwest, died in Los Angeles on July 25 at the age of 79.

Dr. R. A. F. Penrose, Jr., geologist, died in Philadelphia on July 31 at the age of 67. Dr. Penrose graduated from Harvard in 1884. He was first associated with the U. S. Geological Survey, and had since occupied positions with the Texas, Arkansas, and other geological bodies. He was the author of several treatises on geology and was, at one time, associate editor of the *Journal of Geology.* From 1911 to 1927 he was a trustee of the University of Pennsylvania.

R. A. Cook, 44 years old, chief clerk of Nevada Consolidated Copper, and chairman of the Pinal County Democratic Central Committee, died at Ray, Ariz., on July 23, after an operation for removal of his appendix. Starting his mining career in Arizona as an employee of Clara Consolidated Mining at Swansea, after experience in Utah, Colorado, and Nevada, Mr. Cook entered the employ of A. S. & R. at Hayden in 1912. In 1913 he was employed by Ray Consolidated Copper, now part of Nevada Consolidated, and came to Ray as chief clerk in 1914.

INDUSTRIAL PROGRESS

Multiple-Hearth Furnace Is Receiving More Attention for Roasting Quicksilver Ores

THE essential requirements of a furnace for roasting quicksilver ore include its ability to roast the ore completely before discharging it from the furnace, good control of temperature at both the feed end and discharge end, control of the time of treatment of the ore in the furnace, rapid heat transfer, fume-tight construction to avoid leaks, low gas velocity and minimum dusting, low operating and maintenance costs, and last, but of much importance, high thermal efficiency with a minimum volume of exit gases per ton of ore roasted. Thus writes George E. Connolly, chief engineer of the Pacific Foundry Company, Ltd., San Francisco, who also contributes the following.

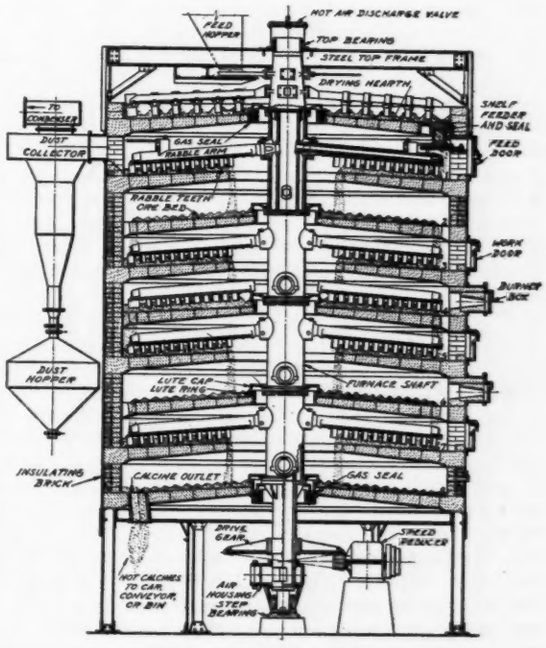
The performance of the furnace has a direct bearing on the recovery of quicksilver after the gases leave it. A furnace that will dust but little and will operate with a minimum amount of fuel per ton of ore will effect a higher recovery of quicksilver in the condensing units than one that creates a high percentage of dust and burns an excess amount of fuel. Although the dust precipitated in the dust collector usually contains only a fraction of 1 per cent of quicksilver, it is clear that the larger the amount of dust, the greater the losses of quicksilver in the collector in the form of metallic mercury and unroasted cinnabar. The products of combustion of the fuel burned in the furnace form the major a part of the gas stream leaving it. A furnace of high thermal efficiency can maintain these gases at a minimum of weight and volume per ton of ore roasted; consequently, the burden placed upon the condensing system is less, or, in other words, a given condensing system is more effective when used in connection with an efficient furnace. Furthermore, the gas volumes entering the stack being less per ton of ore, the uncondensable mercury vapor at the partial pressure and temperature of the stack gases will be less, resulting in a reduction of stack losses.

EXCLUDING retorts that account for a small percentage of the production, the quicksilver mines of the United States have treated their ores in three furnaces—the Scott type, the rotary-tube type, and the Nichols-Herreshoff type. Although the Scott furnace prevailed in the past, it is now practically extinct and no installations have been made for years. The rotary-tube furnace replaced the Scott. The Nichols Herreshoff furnace, owing to its higher thermal efficiency, ability to treat fine ores with a minimum of dusting, lower maintenance and operating costs per ton of ore, and fume-tight construction, is now receiving greater consideration. Mine operators and quicksilver metallurgists of keen ability, eager to effect improvement in the reduction of quicksilver ores, favor it, and the prediction is prevalent that it will replace the rotary for the roasting of quicksilver ores. This is by no means a surprise to engineers and metallurgists who are familiar with the developments in roasting pyrite and ores for the recovery of copper, zinc, tin, molybdenum, and other metals.

The furnace shown in the cut consists of eight superimposed internal hearths and one exterior top drying hearth. Furnaces have been manufactured in sizes ranging from 4 ft. 6 in. outside diameter to 21 ft. 6 in. outside diameter of single-hearth construction, and with as many as sixteen hearths. Hearth-numbering sequence begins with the uppermost internal hearth. The hearths are constructed of special shapes of firebrick to form conical and self-supporting arches, laid in place on wooden forms during erection. The outward thrust of the arches is resisted by a heavy cylindrical steel shell which completely covers the side walls and arches except where openings are provided for mounting gas-tight doors and burner settings. Hearths function as shelves to support the ore being roasted and present a large surface of ore to contact with and to absorb heat from the gases of combustion that flow upwardly and countercurrently with relation to the downward flow of ore through the furnace. The ore is conveyed in a spiral path across the hearths from the center of the periphery or vice versa, alternating in direction as the ore drops through openings provided in the hearths. A single large circular opening is provided at the center of the "in-feed" hearths, and in the out-feed hearths a larger number of smaller openings adjacent to the side walls serve also as large area ports to permit the upward flow of gas at low velocity. The low velocity of gases through the drop holes is responsible for the small amount of dust that is entrained in the gas stream.

Rabble teeth of cast iron or high-temperature alloys placed at an in-feed angle or out-feed angle serve to convey the ore and in so doing form circular concentric ridges throughout the ore bed. The ore surface and gas contact is still further increased by these ridges, and an effective hearth area of 1.4 times the horizontal surface area is obtained.

The rabble teeth are mounted on air-cooled rabble arms, the rabble arms being attached to an air-cooled vertical rotating shaft; rabble teeth or rabble arms can be replaced quickly without cooling the furnace. Pressure air-cooling is effective, as Herreshoff furnaces of standard construction are operating at temperatures 400 to 500 deg. F. above



A nine-hearth (one drying hearth) Nichols-Herreshoff furnace

the operating temperatures of quicksilver furnaces. The rabble teeth, rabble arms, and vertical central shaft—commonly called the rabbling equipment—rotates on a heavy step bearing of special design and is guided by an upper bearing. The speed of rotation of the rabbling equipment is varied to suit conditions, and might be as low as ½ r.p.m. or as high as 5 r.p.m. However, once determined for most efficient operation, it is not changed. Speed being low, the step and top bearings last for years without adjustment or replacement.

The clearance between the rabble teeth and the firebrick hearths is wide. This space becomes bedded down with ore during the first run of the furnace and prevents the moving ore from coming in contact with the brick.

As the central shaft is vertical, it is possible to utilize deep sand seals of overlapping cast-iron rings, independent of alignment and free from wear, without having the rotating ring in contact with the stationary ring or making it necessary to use packing to effect a vapor-tight seal at the top and bottom of the furnace.

The top of the Herreshoff furnace functions as a drying hearth which removes a part or all of the moisture in the ore prior to its entrance into the first internal hearth of the furnace. To the latter hearth the ore is passed from the drying hearth through gates of simple design that prevent leakage at these points. Under the drying hearth at the side wall of hearth No. 1 is mounted a vapor outlet through which the gases of combustion and mercury vapor pass out of the furnace to the dust collector and thence to the condenser. The hot calcines leave the furnace through a single small opening in the bottom hearth. This opening is normally closed and opens momentarily only when a rabble arm passes over it to discharge the ore.

The illustration shows burners on the sixth hearth with hearths 7 and 8 used as cooling hearths. Some air is allowed to pass over the hot ore on hearths 7 and 8 and enters hearth 6 as preheated secondary air for combustion. This arrangement is in use at two quicksilver properties equipped with Herreshoff furnaces, and although the use of this arrangement is somewhat warranted from the viewpoint of reclaiming heat from the hot calcines, the principal object of the additional hearths is for the purpose of providing a soaking compartment to permit heat to permeate the ore particles and to provide a longer time for the escape of mercury vapors from the ore prior to discharge. Soaking pits are placed under the discharge end of rotary tube installations because operators found that this type of furnace does not retain the ore in the furnace a sufficient time for the heat to penetrate the core of the largest pieces of rock to a degree that permits of total dissociation of the cinnabar. The absence of large pieces of ore in combination with the longer period that the ore is in the Herreshoff furnace reduces the need for a soaking compartment, and careful sampling may determine that its use is not necessary. Herreshoff furnaces are made to treat from 200 to 400 tons of quicksilver ore per day in one unit. Natural gas or light fuel oils can be used for firing.

Quicksilver can be released from its ores at a lower temperature and at a faster rate the smaller the size of the ore particles. The experiment of Duschak as tabulated on page 11 of Bulletin 222 of the Bureau of Mines shows a recovery of 98 per cent quicksilver with sandstone ores crushed ⅛ in. to $\frac{5}{16}$ in. when roasted for 25 min. at a temperature of 824 deg. F. (440 deg. C.), whereas the same ore crushed to approximately ¾x1¼x1½ in., when roasted for 30 min. at 842 deg. F. (450 deg. C.), resulted in only 66 per cent recovery.

Table I—Herreshoff Quicksilver Furnace
Operating Cost per Ton

Labor ($5.50 rate for operators)	16.5c
Fuel (at 5c. per gallon)	30.0c
Power (2c. per kw.-hr.)	3.0c
Maintenance, repairs	1.5c
Incidentals	1.5c
	52.5c

Handling fine ore in a rotary furnace creates a large amount of dust, which aside from its being a nuisance in the gas stream, also prevents clean combustion of the fuel oil and increases the amount of soot that passes out of the furnace and into the condensing system. The Herreshoff furnace which will treat ores from 1 in. to 200 mesh, and finer, permits advantage to be taken of the short-time low temperature roast with increased tonnage and an efficiency not attainable in a rotary tube. Rapid decomposition of the cinnabar reduces the opportunity for the released mercury to recombine with elements in the ore or gas stream.

RECORDS of carefully metered oil consumption at the plant of the Pershing Quicksilver Company, Lovelock, Nev., which is equipped with both a rotary kiln and a Herreshoff furnace operating on the same ores, show that the rotary required 45 per cent more fuel than the Herreshoff, both furnaces being rated at 80 to 100 tons daily by the manufacturers. Insulating brick cannot be used in a rotary kiln lining with any degree of stability, whereas the amount of insulating brick that can be placed in the walls of a Herreshoff is not limited. A comparison of the areas of ore exposed to the heat of the gases is interesting and is the principal reason for the lower fuel consumption in a Herreshoff. For example, a 13 ft. 6 in. O.D., eight-hearth Herreshoff and a 48-in. O.D. by 60-ft. rotary have approximately the same capacity. The exposed ore area in the rotary is approximately 150 sq.ft., whereas the effective hearth area of the Nichols Herreshoff is 1,063 sq.ft., a ratio of over 7 to 1 as compared with the rotary.

The rotary kiln at the plant of the Sulphur Banks Syndicate, Clear Lake, Calif., with concurrent flow of ore and gas and wet feed, creates more than 5 per cent dust. That at the Oceanic mine, Cambria, Calif., creates with counter-current flow 2.4 per cent dust. The Herreshoff furnace at the plant of the Consolidated Mercury Mining Company, Morton, Wash., creates ⅛ of one per cent dust. At the Pershing plant even when operated on fines only, the Herreshoff produced less than 1 per cent dust.

In a Herreshoff the only wearing parts are the rabble teeth, a complete set of which averages more than eighteen months' service on quicksilver furnaces. The cost amounts to less than 0.1c. per ton of ore roasted. The firebrick hearths and lining will give better than twelve years' service, owing to the fact that they are stationary, protected from abrasion, and subject to a comparatively low temperature. Contrasting with this, the firebrick lining of a rotary has to be replaced frequently, principally because of abrasion and mechanical injury caused by the rotation of a heavy mass of brick.

A 100-ton Herreshoff furnace is equipped with a 3-hp. motor for the drive, a 2-hp. motor for the cooling air fan, and 3-hp. motor for supplying combustion air at low pressure and for pumping oil; a connected load of 8 hp. with less than 6-kva. input or 1½ kw.-hr. per ton of ore roasted. As only one operator is necessary per shift, regardless of the size of the furnace installation, labor costs per ton of ore roasted are very much less with large installations than with small.

In addition to effecting an increase in the recovery of quicksilver by reducing the outward flow of vapor, the effectiveness of the seals on a Herreshoff furnace reduces the possibility of salivation and prevents infiltration of air at these points. It is extremely difficult in the operation of a rotary tube revolving on a nearly horizontal axis to provide a gas-tight joint between the moving tube and stationary end walls. Several methods are used, but wear and changes caused by heat and expansion rapidly reduce the effectiveness of these arrangements, and a large amount of air is drawn into the furnace, increasing the gas volume and fuel consumption.

Careful control of temperatures in quicksilver furnaces is necessary. The temperature of the exit gases must be kept safely above the dew point of mercury and low enough to prevent an unnecessary amount of fuel burned, as this additional fuel would place an unnecessary burden on the condensers. Furthermore, the temperature of the calcines should not be any higher than necessary to dissociate the cinnabar

completely, particularly in the treatment of ores containing limestone, dolomite, or magnesite, inasmuch as an excessive temperature will increase the amount of carbon dioxide dissociated from these minerals, with a still further increase in fuel consumption and gas volumes. The construction of the furnace, with its superimposed hearths and stationary brickwork, permits the placing of burners at any number of points along the flow of ore, and the vapor outlet temperature can be independently controlled with respect to the temperature of the hot calcines leaving the furnace. By varying the speed of rotation of the central shaft of the Nichols Herreshoff furnace the depth of the ore bed and time of treatment of the ore in the furnace can be regulated.

Should reduction of the tonnage temporarily to half capacity become necessary, the burners would be removed from the lowermost hearths and placed on hearths 3 and 4. This method of operating an eight-hearth furnace would be equivalent in effect to operating a four-hearth furnace equipped with four hearths for cooling. For the mine where it is difficult to deliver ore to the furnace at a rate corresponding to maximum capacity, this is a valuable feature.

The cost of operating a Herreshoff furnace varies with the size of the installation. The figures in Table I are typical of a 100-ton furnace. They do not include crushing costs or power and labor incidental to delivering ore to the furnace or disposing of calcines, nor do they include overhead.

Capital investment charges with interest at 6 per cent and a five-year amortization would result in an addition of approximately 15c. per ton, or interest at 6 per cent and ten-year amortization 10c. per ton.

■

Two-Roll Vibrating Screen Possesses Advantages

Other New Equipment

Claiming that the roller bar and roller-bar screen have been practically abandoned in screening and that their basic fault is their inability to handle pieces that are just above aperture size,

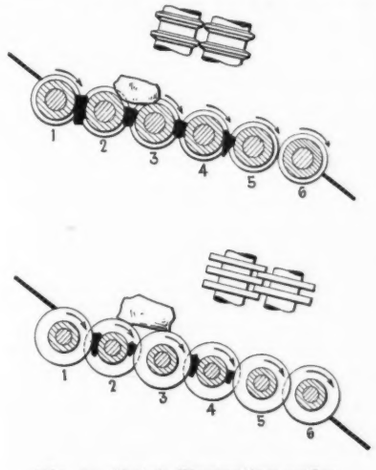


Fig. 1—Sketch illustrating action in a six-roller bar screen

William Ross, of the Ross Screen & Feeder Company, London and New York, set out to eliminate this fault, according to his own statement. The pieces just above aperture size lag behind the main stream and accumulate in and choke the apertures, with attendant shock to the apparatus. Therefore Mr. Ross sought a means of removing them instantly from the apertures, and also a means of avoiding breakage of the material. As a result he evolved a two-roll vibrating screen, the principle of which is illustrated in Figs. 1 and 2. In it, all positive downward motion into the apertures has been eliminated. For example, in a six-roller screen (Fig. 1) rollers 3, 4, 5, and 6 were removed, roller 2 is enlarged and its surface serrated and toothed, and roller 1 was enlarged, made smooth, and left free, instead of being driven as usual (Fig. 2). The serration of roll 2 results in the immediate ejection of oversize pieces from the apertures; in extreme liveliness of the aperture, imparting an intense vibration to the material; in vibrating and shaking the large material in the screening zone above a between the rolls; and in quick discharge of large material. The new screen, according to Mr. Ross, will handle the hardest material without shocks, and the softest without crushing. It imposes no limit on the size of the apertures, which are adjustable to an extent hitherto unthought of. It is built in standard sizes with rolls from 3 in. to 33 in. in diameter and apertures from ½ in. to 9½ in.

Welding Goggles Improved

A new type of welders' goggles (Oxweld No. 12) has been developed by Linde Air Products Company, New York. It is said to have features never before found in safety appliances of this sort. The goggles are designed to fit

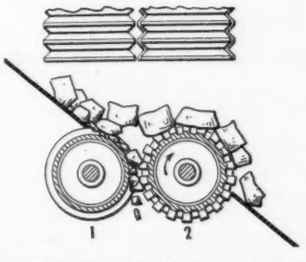


Fig. 2—The two-roll screen evolved from that in Fig. 1

These welding goggles have been designed for comfort and long service

the eyes and can be adjusted to conform to the individual nose. The eye pieces may be correctly spaced according to width of face. They are well ventilated and the field vision has been increased by the use of 50-mm. diameter lenses instead of the usual 47-mm. lenses. The goggles are made of a molded plastic substance formed over a fabric base. This is resistant to heat, light, and electricity.

The same company has also added a cutting blowpipe and cutting attachment to its new line of Prest-O-Weld medium-pressure welding apparatus of the detachable valve body design.

■

Bulletins

Valves. Chapman Valve Manufacturing Company, 203 Hampshire St., Indian Orchard, Mass. Pamphlet, "Forged Steel Globe Angle and Check Valves."

Instruments. Bacharach Industrial Instrument Company, 7000-6 Bennett St., Homewood Station, Pittsburgh, Pa. Catalog, "Instruments for Use in Engineering Schools."

Pulverized Coal. Fuller Lehigh Company, 85 Liberty St., New York City. Bulletin No. 905, "Circular Burner for Pulverized Coal."

Gas Burner. Denver Fire Clay Company, 1742 Champa St., Denver, Colo. Bulletin No. 305A, D.F.C. Refractory (Type A) burner.

Diesel Engines. Cooper-Bessemer Corporation, Mount Vernon, Ohio. Folder on new Type JT diesel engine.

Diesel Engines. Ingersoll-Rand Company, 11 Broadway, New York City. Catalog, "Solid-Injection Diesel Engines."

Excavators. Bucyrus-Erie Company, South Milwaukee, Wis. Bulletin No. FBE-371, 37-B gasoline diesel electric.

Centrifugal Pumps. Worthington Pump & Machinery Corporation, Harrison, N. J. Types CA and CB. Specification Sheet W-310-S12A, 4 pages, and Type WF, multi-stage turbine. Specification Sheet W-319-S3, 4 pages.

Protective Hats and Caps. Mine Safety Appliances Company, Braddock, Thomas and Meade Sts., Pittsburgh, Pa. Bulletin No. 58.

Gas Air Excavators. Bucyrus-Erie Company, South Milwaukee, Wis. Bulletin No. FGA-31, GA-3.

Water Conditioning. Elgin Softener Corporation, Elgin, Ill. Sixteen-page book entitled "Boiler Water Conditioning."

NEWS OF THE INDUSTRY

Sidney Mine Resumes Output to Supply Sullivan Plant

Operations have been resumed at the property of Sidney Mining, near Kellogg, in the Coeur d'Alene district of Idaho, so as to provide the Sullivan Mining electrolytic zinc plant with a steady supply of zinc concentrate. Output will be at two-thirds of the normal rate of 150 short tons of ore daily. The ore, carrying about equal quantities of lead and zinc, is transported by cable tramway to the Bunker Hill concentrators at Kellogg. Operation of the property is actually undertaken by Sidney Leasing, which pays a 15 per cent royalty to Sidney Mining, which owns the ground.

The Sullivan Mining electrolytic zinc plant is running at about half of its capacity of 60 tons of metal daily. Because of increased consumption of its product, which is of exceptionally high grade, the stocks of metal on hand are decreasing and the company desires to maintain operations, even with current low prices. The only large zinc producer of the Coeur d'Alene district still in operation is the Morning mine, which sends its concentrate under contract to Anaconda Copper. Bunker Hill & Sullivan and Hecla Mining, joint owners of Sullivan Mining, produce only limited amounts of zinc concentrates, as their ores are chiefly silver-lead.

The Star mine, formerly the chief source of supply for the Sullivan plant, is closed and the available supply of concentrate has evidently been used. On the basis of a 100-ton operation daily and with an 80 per cent recovery of its zinc content, the Sidney mine will be able to supply about 20 tons of concentrate daily. Before closing down, early in 1930, development had struck a new orebody west of the shaft on the No. 7 level, then the deepest in the mine. The shaft has since been deepened to No. 8 level.

■

Benguet Ex. Considers Mill

Preliminary surveys of the ground held by Benguet Exploration near the Balatoc mine, in the Baguio gold district, Philippine Islands, have justified intensive development work, preparatory to installation of a mill, according to H. P. Whitmarsh, president of the company. The company holds four groups of claims—the Contact, Extension, Prospector, and Thanksgiving. Development will be centered on the first two of these, promising material having been uncovered in the Contact claims by J. H. Sampson, the company's engineer.

In addition to exploring these deposits, which are of a grade comparable to that at Balatoc or Benguet Consolidated, the company is investigating the possibility of attempting exploitation of low-grade deposits. Mr. Whitmarsh states that throughout the district, large quantities of material running $5 a ton in gold are available. None of the large producers in the area handle ore averaging under $10 a ton. The capital of Benguet Exploration has been increased from 500,000 to 1,500,000 Philippine pesos, but the additional stock is being held in the treasury for possible future financing.

■

Underground Work at Vulture Suspended by U.V.X.

In a report dated Aug. 1, James S. Douglas, president of United Verde Extension, states that prospecting at the Vulture gold property, near Wickenburg, Ariz., has failed to disclose any ore. All work has ceased except some diamond drilling, which is now being carried on. The company took an option on this property several months ago, after diamond drilling by the owners had cut ore beyond the faulting system which had baffled former operators. U.V.X. sunk a three-compartment shaft to 500 ft. and then did considerable underground development. Although the Vulture vein was found, the gold content was small.

With regard to the new work on the Haynes group, at Jerome (to which reference was made in the July 13 issue of *E.&M.J.* Mr. Douglas states that promising mineralization has been disclosed. "Too little is known as yet to warrant conclusions that further development will disclose a valuable orebody," he adds. This work is being done under contract by United Verde Copper through one of its own shafts, as the Haynes ground is at a considerable distance from the U.V.X. workings.

■

Senators Work on Silver Plan

A meeting of legislators and mining men who are interested in improving the status of silver was held at Boise, Idaho, on July 27. Among those present were Senators William Borah and John Thomas, of Idaho; Senator Reed Smoot, of Utah; W. Mont Ferry, G. W. Snyder, J. O. Elton, and F. B. Cook. No announcement was made after the meeting of any proposals for the solution of the silver situation, but an agreement was reached that an international conference is essential. A plan, suggested by Senator Smoot, will be presented to President Hoover before being made public.

■

Lease Katherine Tailing Dump

The tailing dump at the Katherine Gold property, in the Union Pass district, 30 miles west of Kingman, Ariz., has been leased to Jack Taylor, James Shaw, and Charles Toos. The property has been idle since late in 1929, when the operating company was declared bankrupt. Plans of the leasers are to transport the material to the mill with scrapers and to treat it there by cyanidation. Mill capacity is about 300 short tons daily.

Bunker Hill and Hecla Men in New Metaline Falls Company

Formation of Leadhill Mines, which held its first meeting in Spokane, Wash., marks the entry of a new company into the Metaline Falls lead-zinc district, of northern Washington (also referred to sometimes as the Pend Oreille area), and a company, furthermore, that includes on its directorate the guiding spirits in the Bunker Hill & Sullivan and Hecla Mining companies, leading lead producers of the Coeur d'Alene district of Idaho. Leadhill Mines holds a property on Slate Creek, 7 miles from the main Pend Oreille highway.

Stanly A. Easton, vice-president and general manager of Bunker Hill & Sullivan, is the president of Leadhill Mines. B. H. Kizer, local attorney, is vice-president of the company. L. K. Armstrong, mining engineer, of Spokane, who is credited with bringing the property to the attention of Bunker Hill, is secretary-treasurer. On the board of directors are F. W. Bradley, pesident of Bunker Hill & Sullivan and leader in a score of mining enterprises throughout the United States and Canada, and James F. McCarthy, president and general manager of Hecla Mining. Bunker Hill and Hecla are also associated in joint ownership of Sullivan Mining, operating the only electrolytic zinc plant in Idaho, as well as the famous Star mine.

Last February an announcement was made that Bunker Hill had taken an option on seventeen claims in the Slate Creek area and that $200,000 would be paid if the option were exercised, payments to be spread over a period of four years. A small force was then put at work on the property. No data have been made available on the results of development of the lead-zinc deposits, but it must have been favorable, or the operating company would hardly have been organized.

The Pend Oreille area has been recognized for some time as of potentially great importance in the production of lead and zinc. The one circumstance which has stood in the way of its development is the comparatively low tenor of the deposits. Large tonnages have been blocked out in the properties of Pend Oreille Mines & Metals, Reeves-MacDonald Mines, and Grandview Mines. Difficulties over power, low metal prices, insufficient funds for proper equipment, and other handicaps have limited production. At present, Pend Oreille is mining about 200 to 300 tons of ore daily and shipping zinc concentrate to the East St. Louis plant of American Zinc and lead concentrate to the Kellogg plant of Bunker Hill. Grade of the zinc concentrate is exceptionally high (62 per cent). Grandview operated a new 200-ton mill in 1929, closing when prices fell.

Within the last few months, engineers representing many prominent zinc producers are reported to have visited the area, including Universal Exploration (zinc-mining subsidiary of U. S. Steel) and Eagle-Picher Lead. So far as is known, these companies have not made any offers in regard to property in the district.

Settle Conflicting Claims on Mexico's New Gold Area

An arrangement whereby the claimants agree to operate jointly and to share proceeds equally has eliminated the difficulties that arose from disputes over the ownership of ground in the new El Tambor gold district, Sinaloa. Six different sets of claimants had been contesting possession of the placer holdings. The arrangement was made by General Macario Gaxiola, the governor of the state, and General Juan Dominguez, chief of military operations in Sinaloa. They had been appointed by the Minister of Industry, Commerce, and Labor to handle the situation.

Conflicting denouncements covering the gold strike in El Tambor Mountain, Sinaloa, Mexico, are in status quo, according to an earlier report from Mazatlan, by E. W. Eaton, American Vice-Consul. A gold-bearing quartz vein has been discovered near the placer deposit that occasioned the rush last January. Wild rumors, accompanied by a great deal of affected secrecy, are still in circulation, but Mr. Eaton learns from several individuals who have visited the camp that the richness of the strike has been greatly exaggerated.

The gold apparently is distributed through a narrow crack in the quartz. At irregular intervals soft pockets occur, in which small nuggets ranging in size from a pinhead to a small pea are frequently found. Some of the small pockets taken out for assaying naturally have run very high. Published reports of such assays make it appear that the ore is fabulously rich, although an assay of the run-of-mine ore would be very much lower.

■

War Eagle Mill Running

The War Eagle mill, at Manhattan, Nev., has been put into commission. It is operating on ore from the old Mustang Extension property and about 300 tons from the surface dump at the Gold Metals mine. This dump material is estimated to contain from $12 to $14 a ton in gold. Transportation charges are too high to permit shipping it outside the camp. A force of sixteen men is employed at the Gold Metals property, which has recently been listed on the San Francisco mining exchange. Shaft sinking to 400 ft. from the 170 level is under way. In addition, one shift is drifting on the 170 level, where ore of shipping grade has been developed.

■

Siscoe Reports Higher Grade

Grade at Siscoe Gold, operating in northwestern Quebec, east of Rouyn, is improving steadily, according to a report of J. M. Forbes, general manager of the company, covering the first half of the year. For the first six months of 1931, the average was $14.11 per ton, from which $13.88 was recovered—an extraction of 98.3 per cent. In 1930, the average yield was $11 per ton. Costs are down to $6.60 per ton, before depreciation, on the basis of 150 tons milled daily.

Ore reserves are put at about 100,000 tons, but Mr. Forbes states that additional ore is being put in sight at a rapid rate. Further development will be necessary to outline reserves above the 600 level. Work at that depth has just been started on the western ore zone. The management has as its objective development of three years' reserves for a 400-ton daily operation. Actual production in the first half of 1931 was $334,836.

■

Placer Find in Okanagan, B. C.

Reported discoveries of high-grade gravel deposits along Barnes Creek, tributary to Lower Arrow Lake, in the nothern section of the Okanagan area, British Columbia, have created considerable excitement. The discoveries are about 18 miles from Edgewood, the nearest settlement. Numerous parties have arrived at the scene of the discovery and more than 150 claims have already been staked for a length of 6 miles along the creek.

■

Barry Hollinger Sinking Again

Results on the bottom level of the mine —the 1,875—are reported to have been disappointing at the Barry Hollinger property, in the Boston Creek section of the Kirkland Lake camp, Ontario. As a result, the company is putting down the main winze, preparatory to opening up a new level at 2,000 ft. The levels directly above the 1,875 were the best in the mine, and the management evidently hopes that the good ore will reappear with additional depth. Production is running about 100 short tons of ore averaging $7.50 per ton in gold.

■

Mount Lyell Tonnage Rising

Mount Lyell Mining & Railway, largest producer of copper in Australia, is gradually bringing its tonnage up to the capacity provided for by the program of plant construction, now nearly completed. The plant, near Queenstown, Tasmania, Australia, is now handling more than 850 long tons of ore daily, with copper production at the rate of better than 10,000 long tons annually. The additional ore is being obtained from the Lyell Comstock and Crown Lyell mines, which carry lower-than-average grade ores but which, because of their size, can be exploited at low costs. As soon as the construction program is completed, the rate of copper production will be increased to 13,000 long tons by stepping up the ore mined to 1,000 tons daily.

■

Broken Hill South Remodeling

By the end of July, Broken Hill South, lead-zinc producer operating in the Broken Hill district of New South Wales, Australia, was expected to have its new No. 7 hoisting shaft in operation, according to a report from Melbourne. The new central power plant, consisting of six large diesel engines, built by the Broken Hill companies, was expected to be ready by that time. The hoisting plant at the new shaft, which has been sunk during the last two years, consists of two hoists and is housed in a reinforced-concrete structure. Broken Hill South's shaft headframe is all steel. A new crushing station and conveying system have been erected at the shaft as well. This installation makes the company's surface plant the most modern in the district. The company has recently completed its new mill, with a capacity of 7,000 long tons of ore weekly.

Complete First Crushing Unit at Lake View & Star

At the Lake View & Star gold mines, in the Kalgoorlie district of Western Australia, construction of the new crushing and treatment plant is proceeding steadily. The first section of the crushing plant has been completed and was placed in operation recently. The second section will be completed when the present repairs and alterations to the Chaffers shaft are finished. Then the crushing plant will be centralized on the Chaffers lease, adjacent to the new flotation treatment plant, and will obviate crushing at the other shafts on the Lake View group before treatment. Lake View & Star will have a capacity of 1,000 long tons daily when the present remodeling is completed. At present about two-thirds of this tonnage is being handled. Leasers furnish a large part of the tonnage.

The first section of the crushing plant has a capacity of 80 long tons per hour, and consists of a Gates gyratory crusher and a Symons cone crusher, which reduces the ore to ½-in. size. Before the ore on the conveyor belt enters the Symons crusher, the belt passes under an electric magnet, which removes all pieces of metal from the ore.

In the flotation section of the plant, two wet ball mills to replace the dry mills have been put in operation. Four more will probably be installed. Each mill has a capacity of 250 tons per 24 hours and is driven by 100-hp. Texrope drive, which is a special feature of the plant. The new classifier, tube mill, and flotation machines are expected to be running soon. The three thickener tanks, each 50 ft. in diameter and 10 ft. deep, have been erected. Two of the new Fahrenwald flotation machines are practically completed, and the foundation and brickwork for the dryers have been erected.

Work on the Chaffers shaft continues. One of the two hoists from the Horseshoe shaft has been placed in position.

■

Australia Cuts Gold Bounty

Because of the financial situation in which it now finds itself as a result of worldwide depression, the Australian federal government has decided to reduce the bounty on gold production which will be paid at the end of this year. The new rate will be 10s. per ounce for any production in excess of the average output in the three years, 1928-30. The former rate was £1 per ounce. A compensating factor for the gold mines, however, has been the increase in the adverse rate of foreign exchange. Gold producers now obtain 30 per cent over the nominal value of their output by virtue of depreciation in Australian currency. When the bounty act was passed the premium was only 9 per cent.

■

Samoa Gold in Chloride Area

Samoa Gold, recently incorporated in Delaware, has taken over the Samoa and Lucky Boy groups, in the Chloride district, of Arizona. A short tunnel will be continued to cut all the veins on the property, reaching the Samoa at a depth of 720 ft. from the surface. Some of the veins are gold bearing, and one, beyond the Samoa, is reported to have shown high-grade silver. Construction of a wagon road to the property is under way.

Morenci Leading P. D. Units in Safety Contest

The Morenci branch of the Phelps Dodge Corporation, at Morenci, Ariz., of which Frank Ayer is manager, stepped into first place in June for the James Douglas Memorial Trophy. This trophy is awarded annually to the branch or company in the Phelps Dodge Corporation recording the minimum accident rating for the year. The Morenci branch first won the trophy in 1928 and has been successful in holding it for the year 1929 and 1930.

At the end of the first six months of 1931 the branch again attained first place with two lost-time accidents recorded for the period. This gives a figure of 0.013 lost-time accidents per 1,000 shifts worked.

Many of the departments have gone a considerable period without a disabling accident. The smelter at Clifton has a period of two years and 136 days, or 146,473 man-shifts, to its credit. The mechanical department has worked one year and 320 days, with 123,170 shifts, free from a disability. Underground mining completed 256 days, a total of 103,575 man-shifts, and the concentrating department's record is one year and 76 days, or 86,160 man-shifts. The best record for the branch as a whole was 183 days, having worked during that time 211,343 man-shifts, or 1,690,744 man-hours, without a time-lost accident.

The Copper Queen branch, with only one time-lost accident for the month, was second in June; Moctezuma, with three, was third; the Stag Canyon branch, with one, was fourth, and Old Dominion, of Globe, with five, was last. All seven accidents were in the underground mining departments. A total of 34 time-lost accidents have been chalked up against the five branches for the year to date. Morenci has had only 2; the Copper Queen, 11; Moctezuma, 4; Stag Canyon, 3; and the Old Dominion, 14.

■

Will Drill Alaskan Placer

Drilling of a placer area of 2,000 acres of Klery Creek, in the Kobuk district, about 60 miles east of Kotzebue, northwestern Alaska, Alaska, will be undertaken by W. H. Suksdorf and associates. The drilling equipment is now being shipped to the property, which is held under option. Mr. Suksdorf states that the area has never been worked by proper equipment, but that production has been about $500,000 in placer gold. If the drilling is successful, a dredge will be installed. Dredging equipment can be brought to within 8 miles of the property by water.

■

Sue Aluminum "Monopoly"

Suit has been filed against the Aluminum Company of America on the basis that it is a gigantic monopoly. Action was taken by the Baush Machine Tool Company, of Springfield, Mass., in the district court at New Haven, Conn. The plaintiff claims damages for injury to its business and property, allegedly suffered as result of price discriminations given to the Aluminum Company subsidiaries. The Aluminum Company is stated to be the only manufacturer of aluminum in the United States and the possessor of all the bauxite deposits in the United States, as well as most of the patents for aluminum manufacture. [There are several small independent bauxite producers in Arkansas and Georgia, but the ore is not used for making aluminum.—Editor.]

■

Mexico Stops Coining Gold; Silver Peso Legal Unit

The Mexican government has established the silver peso as its sole monetary unit. Minting or circulation of gold is prohibited and gold coin and bars may be freely exported. This step has resulted in a drop in Mexican exchange and has increased the value of silver production within (but not without) the country. It means that the government has lowered the standard of living of its people in order to permit its industries to compete in the outside market.

The result of the law on the mining industry cannot be foretold immediately. What appears likely to happen is that companies such as those in the Pachuca and El Oro districts that carry a considerable gold content in their silver ores will increase their production and export gold, which they can then exchange into a larger number of Mexican pesos than was possible formerly. These pesos, in turn, will have the same purchasing power in terms of labor as did the currency before the new monetary code was introduced.

■

Deepen Both Noranda Shafts

Noranda Mines will deepen both its main hoisting shafts at the property, Rouyn, Que., to 2,500 ft. as a preliminary to further diamond drilling of the orebodies at depth. Earlier in the year, a series of drill holes put down from the 1,500 level indicated the existence of high-grade copper-gold ore to a maximum depth of 2,700 ft. The expectation is that from the 2,500 level the company can determine ore conditions between 3,000 and 4,000 ft. At the end of 1930, Noranda had reserves of nearly 8,000,000 short tons of direct-smelting and milling ores—about ten years' supply. This figure has undoubtedly been increased by the more recent work. No. 3 shaft will be put down first in the sinking program, and then the same crew will deepen No. 4 shaft.

■

Nevada Feldspar Property Ships

Three 60-ton carloads of feldspar have been shipped from the property of Nate Kearns and sons, near Peavine siding, 18 miles north of Reno, Nev. The property is 10 miles from the railroad. Shipments are consigned to the American Development Company, at Berkeley, Calif., which is paying $10.25 per ton for feldspar, f.o.b. Berkeley. Railroad freight from Peavine to Berkeley is $2.30 per ton, leaving $7.95 to cover mining and trucking charges. At present, ore is extracted entirely by surface quarrying from a deposit 1,500 ft. long and 4 to 18 ft. wide. It has been explored to a depth of only 15 ft. In addition to feldspar, analyses of the material made by the Mackay School of Mines have indicated the presence in the deposit of rare metallic ores.

So far as can be determined, this is the first commercial exploitation of a feldspar deposit in Nevada.

C. V. Bob Will Sue to Regain His Mining Interests

Attorneys for Charles V. Bob, mining stock promoter, following a hearing in bankruptcy before Referee Robert P. Stephenson, have announced that suit will be brought to recover properties worth $6,000,000 which, according to testimony at the hearing, were turned over to August Heckscher through the latter's attorney, George Thompson, under an agreement unwillingly signed by Bob to obtain bail. Mr. Thompson, commenting for Mr. Heckscher, has stated that no such agreement had been made between Mr. Heckscher and Bob, but there were papers relating to certain acts of officers of the Bob companies that bore Bob's signature of approval.

Under examination by Karl T. Frederick, counsel for the Irving Trust Company, receiver, Samuel Hartman and Thomas Sheridan, of the law firm of Hartman, Sheridan, Tekulsky & Pecora, testified to certain conversations they had with Mr. Thompson concerning bail for the promoter. Mr. Thompson had promised, they testified, that Mr. Heckscher would provide the bail, but when the formal agreement was made, Bob was asked to sign certain papers turning over the property to Mr. Heckscher and associates three weeks after receivers were appointed for the estate. The paper was made while Bob was under indictment and held in $50,000 bail. The result of the agreement, according to the testimony, has deprived creditors of Bob of about $800,000 in claims against him as well as 900,000 shares of stock to which his estate is entitled. Despite the agreement, it was said, Bob was forced to obtain bail elsewhere.

Milton Seymour Cohen, attorney for Bob, and the stock promoter himself, who was at the hearing, asserted afterward that if the properties were recovered the estate would be in a position to pay all creditors in full and that about $1,500,000 would be left for Bob.

■

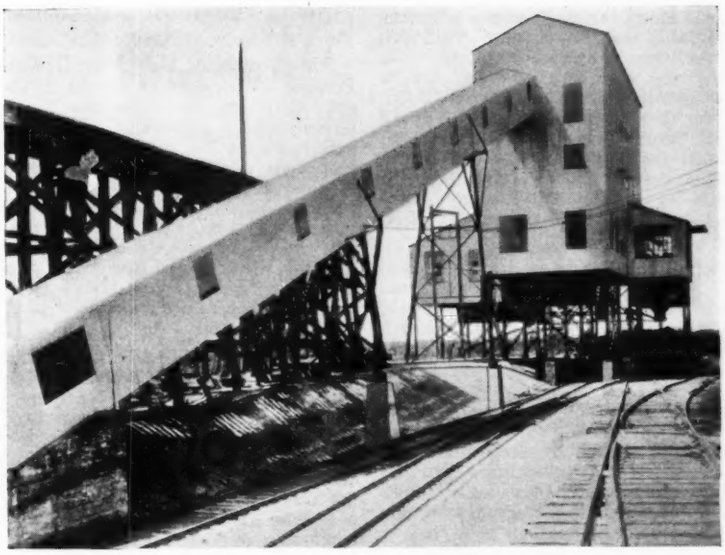
Dismantle Mineral Hill Plant

Work of dismantling the plant of Mineral Point Zinc, subsidiary of New Jersey Zinc, at Mineral Point, Wis., has been started. The company has not been active in the Wisconsin zinc field for the last few years, its mines having been closed in 1928. Although the plant was operated on purchased concentrate, production was small and it was finally closed last fall. Equipment consists of roasting and separating units, capable of handling about 200 tons of concentrate daily, and a four-block zinc-oxide unit. Several independent mines are still running in the district, but they are shipping ore to Illinois smelters.

■

Suspend Work on McCormick Claims

Development of the McCormick quicksilver property, on Buckskin Mountain, near Winnemucca, Nev., has been suspended by the Bradley interests, which have been operating under bond and lease. About fifteen men were employed. Chalmers McCormick, owner of the property, states that he is not aware of the future plans of the leasers. The drop in the price of quicksilver probably was responsible for the shutdown.



Mesabi Chief washing plant, Nashwauk, Minn.

Test Missouri River Placers

To test the sands of the Missouri River in Montana for gold, Prof. Oscar A. Dingman, of the Montana School of Mines and the state Bureau of Mines, has constructed a flat boat, equipped with all kinds of placer gold recovery devices, according to Dr. Francis A. Thomson, president of the school of mines and director of the state mining bureau. Accompanied by Jesse Cobb, pioneer prospector and placer miner, Dr. Dingman will float down the Missouri from Fort Benton until all placer indications are exhausted. He hopes to find deposits which may be leased from the farmers by the unemployed and worked at a profit. The idea was originated by State Senator W. T. Cowan, of Hill County.

■

Big Belt Shaft at Bedrock

Big Belt Gold Mining, operating at Magpie Gulch, in the Canyon Ferry district of Montana, has struck bedrock at 60 ft. in its No. 4 shaft on the west rim of the north channel. At that point the shale bedrock panned about 8c. per pan. A drift is now being driven to the center of the channel, where the grade is expected to be higher. The company has been delayed by water problems, but expects to be in production soon. The ground owned by Big Belt is situated between two plots that have produced heavily in the past. J. W. Kager, of Butte, is managing director.

■

August Mine Ships Rich Car

Charles Whitcomb, one of the owners of the August mine, in the Little Rocky Mountains, Phillips County, Mont., states that the last car of gold ore shipped consisted of 40 short tons and had an assay value of $14,400. In the same district, interests affiliated with Newmont Mining have completed an examination of the Ruby Gulch mine, near Zortman.

Butte Out for Field Day

At the annual Butte miners' field day, held at Columbia Gardens, Mont., east of the city, on July 27, more than 20,000 people attended. John L. Boardman, head of the safety bureau of Anaconda Copper Mining, was in charge of activities, which included athletic events, safety-first method exhibitions, and mucking contests. Walter Smith, of the Badger mine, won the mucking contest, filling the mine car in one minute and 44 seconds. Fifty-nine shovelfuls were required to fill the car.

■

Order Dredge for Alder Gulch

California-Alder Gulch Corporation has ordered a dragline dredge of 1,500-ton capacity per day to work the placer ground in Alder Gulch near Virginia City, Mont. The dredge will be electrically driven and provided with a steel boom, so that it may be used either as a dragline or shovel. Prospect samples show the southern part of Alder Gulch to contain gravel 12 to 50 ft. thick over a width of from 200 to 500 ft. At the company's "lava-capped" placer deposit a tunnel is being driven to test the gold-bearing channels. Frank Zichosch is president and managing director.

■

New Falconbridge Ore at 350

On the 350 level of the Falconbridge Nickel property, in the Sudbury district, Ontario, drifting has proceeded westward in good ore, the company's quarterly report states. In addition, a raise has been put up from 1,000 to 700 ft. to improve ventilation. Crosscuts to the orebody from the raise have given satisfactory results. Other development work has been limited. Production was lower in the second quarter of 1931 than in the first because of the time lost during the smelter shutdown, resulting from an accident to the converter blowing equipment. Ore output was 23,900 short tons, compared with 26,624 tons in the preceding quarter. Matte produced contained 1,103,612 lb. of nickel and 414,968 lb. of copper.

Committee Releases Details of Fall Meeting in Joplin

The joint committee in charge of arrangements for the ninth annual meeting of the Western division of the American Mining Congress and the regional meeting of the A.I.M.E. at Joplin, Mo., has sent a letter to 1,500 mining men, giving the details of the meeting. It will be held on Sept. 28-30 at the Connor Hotel and will include trips throughout the Tri-State zinc-lead district.

On the first day, the program will be devoted largely to a symposium on the "Geology and Ore Deposits of the Ozark Region." This has long been a controversial subject, and studies made within the last few years have added to the available information. The second day will be devoted to Western mineral problems. Topics will include discussions of the economics of silver, lead, zinc, freight rates, stabilization, and regulation. The third day will be devoted to a field trip covering mines, mills, and the Eagle-Picher lead smelter. Further excursions to near-by plants will be arranged for those who can stay longer. The convention committee can be reached at Box 556, Joplin. C. F. Dike is governor of the Western division of the American Mining Congress and G. M. Fowler is chairman of the Joplin-Miami section of the A.I.M.E.

S. Livingston Mather, of Cleveland, vice-president of Cleveland-Cliffs Iron and president of the American Mining Congress, will speak on what the mining industry is doing to promote industrial prosperity, and his address promises to be of nation-wide interest. Other subjects to be considered by the convention are silver and world prosperity, to be presented by W. Mont Ferry, of Salt Lake City, president of the American Siiver Producers' Association; commission regulation versus private operation of minerals, by Robert E. Tally, vice-president and general manager of United Verde Copper and president of the A.I.M.E.; varied problems facing mineral producers, by J. F. Callbreath, of Washington, D. C., secretary of the American Mining Congress; and stabilization of the natural resource industries, by Dean Frank H. Probert of the University of California.

Tentative speakers include Ralph M. Roosevelt, vice-president, Eagle-Picher Lead; Frank M. Smith, Bunker Hill & Sullivan; F. H. Brownell, chairman of the board of American Smelting & Refining; and P. G. Beckett, of Phelps Dodge.

■

Bureau of Mines to Drill for Potash in Utah

The U. S. Bureau of Mines will drill a well for potash in Grand County, Utah, 19½ miles south of Thompsons and 1½ miles from the oil well of the Utah Southern Mountain States Oil companies. The contract for drilling the well has been awarded to the Sullivan Machinery Company. C. C. Tredway, of Chicago, will have charge of the operation and W. J. Whitman will be foreman.

About 75 tons of machinery have been shipped into the field from Carlsbad, N. M. Drilling equipment consists of a rotary rig. The overburden will be drilled with a fishtail bit and a 2½-in. core taken of the salt formation. The well will be drilled from 1,700 to 2,100 ft. deep. This work is part of a $500,000 program for the development of domestic potash resources.

BRIEF NOTES

Amparo Exploration to Continue. Rumors that the company intends to suspend operations in the near future at its mines of La Asuncion y Anexas have been denied by officials of Amparo Mining & Exploration, which has been developing the property, in the Guanajuato district, Mexico. It is a gold-silver mine and was taken over by Amparo last year. According to the officials, the Department of Industry, Commerce & Labor has granted the company an additional year's time for development purposes.

Coniaurum Cuts New Ore. At the Coniaurum Mines property, in the Porcupine district, Ontario, drifting on the 1,750 level has shown 50 ft. of ore, averaging 6 to 10 ft. wide, that runs well above the mine average. On the 2,000 level, in the same section of the mine, drifting over a length of 200 ft. has shown ore of about the average grade. This appears to be the downward extension of the high-grade orebody. There are possibilities for adding to this ore both above and below the two levels on which it has been opened. Ventures, Ltd., has a large interest in Coniaurum, which continues to mill about 300 short tons daily.

Copper Range Drilling. The drilling program of Copper Range in the Globe property, south of the Champion mine, near Painsdale, Mich., is being continued. Two drill holes are now being put down, one drill being still in the ledge, though the other continues in overburden. Both will cut the Baltic formation, in which a good showing is apparent in two other holes. Production is about 1,500,000 lb. of copper monthly, or 30 per cent lower than the 1930 monthly average. Of this, Baltic is producing about 250,000 lb. from mining pillars. Exhaustion of this source of ore is expected some time in the fall, when the mine will shut down and only Chamtion will continue to produce.

Copper Nickel Is Liquidating. Copper Nickel, Ltd., operating a property at Zeehan, Tasmania, Australia, has gone into voluntary liquidation, thus dealing another setback to the development of the copper-nickel lodes in the district. The drop in the price of the ore, which was exported to Europe, was responsible. The leases, comprising 137 acres, and the plant will be auctioned. Several lenticular orebodies have been developed and some shipments have been made of ore averaging 11 per cent nickel and 6 per cent copper.

Dos Estrellas Measures Ore. Reserves of ore at the Las Dos Estrellas mine, in the El Oro district, Michoacan, Mexico, were 523,000 metric tons and at the Esperanza mine, 400,000 metric tons, at the end of 1930, according to H. E. Nyberg, general manager of Compagnie Minère "Las Dos Estrellas." These reserves are based on a silver price of 35c. an ounce. At present silver prices, the mines cannot be worked at a profit and should be shut down, he believes. Development in the Esperanza property has permitted an increasing output which has counter balanced with the decline from the Dos Estrellas, now near exhaustion. In 1930, the mill handled 759,056 tons of an average grade of 3.9 grams of gold and 141.8 grams of silver per ton.

Esmeralda Gold Gets Equipment. Machinery purchased from Last Hope Mining is being installed at the property of Esmeralda Gold, operating at Gilbert, Nev. As soon as the new equipment is installed, the company will be able to resume sinking of the shaft, now 100 ft. deep. In the meantime, ore of shipping grade is being drawn from the face of the south drift, 20 ft. from the shaft, and is being stored in the ore bins. Four carloads of ore have already been shipped, with the yield reported at better than 2 oz. of gold per ton.

French Creek Ready to Start. French Creek Development, which controls bench and creek leases on French Creek, in the Big Bend district, 70 miles north of Revelstoke, B. C., reports that it is ready for production. This property has been under development by the present owners since 1927. Glacial clay deposits have been removed to obtain bedrock drainage. Test drilling apparently justifies large-scale operation. Production will be started by two No. 6 Hendy Giant monitors, with 7-in. nozzles operating under a 65-lb. head.

Gold Hill Deepens Shaft. The main shaft of Gold Hill Development, near Round Mountain, Nev., is being deepened from 400 to 500 ft. To date the company has developed its orebody on only two levels—the 225 and the 400. Production is being maintained at the rate of about 100 tons of ore averaging $8 per ton in gold daily. A. T. Staples, mine superintendent, has resigned and has been succeeded by George S. Spitzer, superintendent of Tonopah Mining for twenty years.

Great Western Sinking Shaft. A shaft is being put down on the property of Great Western Copper & Lead, near Lane, in the Coeur d'Alene district, Idaho. Its objective is 400 ft., diamond drilling having indicated favorable conditions at that depth. The shaft is being put down on the vein, said to be 30 ft. wide by Jackson C. Hill, of San Francisco, who is interested in the company. Ore extracted in sinking will be shipped to the near-by Bunker Hill smelter.

Hoge Development Sinks Shaft. The three-compartment incline shaft at the property of Hoge Development, 4 miles north of Nevada City, Calif., will be deepened from 300 to 600 ft. Lateral work will then be undertaken at the 450 and 500 levels to prove downward continuation of ore from the 300 level. Construction of a modern flotation plant may be undertaken if the development is successful. The company has both gravel and lode deposits on its property. Recently it has shipped about 300 short tons of ore from the lode orebodies. According to A. W. Hoge, managing director of the company, about $100,000 has been made available for the development and equipment program. O. E. Schiffner is general manager.

Nevada Montana Starts Plant. The gravel plant at the property, consisting of 4,160 acres of placer ground at Placeritos, 52 miles north of Lovclock, Nev., has been put into operation, according to Ira Stanley, general manager. H. F. Buerer and his son, Wayne Buerer, have contracted to deliver 200,000 cu.yd. of gravel into the company's hoppers at the rate of 200 cu.yd. daily. This is estimated to be the capacity with the water supply now available. When more water can be obtained, the capacity will be increased to 300 cu.yd. daily. Water is piped 5½ miles with a gravity flow of 400 ft. Pipe tapers from 5-in. size to 2-in. Storage tanks with a capacity of 150,000 gal. are maintained at the plant.

Rio Tinto to Use Five-Day Week. Because of inability to sell its entire production of copper and pyrites, Rio Tinto, largest copper producer in Europe, asked permission of the Spanish government to reduce its working force at the properties in Huelva. After a conference with government officials, however, decision was made to put the entire force on a five-day week instead. The company hopes that the workers will accept the step as a necessary one. Other Huelva copper-pyrites producers are understood to be considering the same step.

Seven Troughs Shuts Mill. Operation of the 100-ton cyanide plant, which was completed near Lovelock, Nev., by Seven Troughs Gold last summer, has been suspended. The plant, operated at full capacity at first, had produced as much as $50,000 from high-grade gold ore monthly, but for the last few months the mill tonnage has dropped off. A small force is continuing development work at the property, under the direction of J. A. Friedman.

United Operating Drifts on Ore. The lower tunnel in the Mabel claim of United Operating Trust, operating in the Silverton district of Colorado, is following a vein that carries some high-grade gold ore, according to T. P. Mitchell, general manager of the company. Two shifts are now employed in driving this tunnel, which is in more than 400 ft. from the portal. The depth is about 100 ft. below the surface. The property has recently built a power line to connect with the main line. Formerly operations had to be conducted entirely by hand drilling.

Vieille-Montagne Curtailing. Vieille-Montagna, Belgian zinc producer, has denied officially that its Angleur plant will be shut down as result of the agreement reached by zinc cartel members to curtail production 45 per cent. The decrease in its production will be made by reducing the rate of operations at various plants and undoubtedly advantage will be taken of the curtailment to modernize the company's various smelters. The Borbeck smelter, in Germany, has been closed. During the last two years the company has been modernizing its equipment, and already the Baelen and the Flon plants have been completely modernized.

West Rand Fire Cuts Output. The fire which occurred at the West Rand Consolidated property, on the West Rand, Transvaal, South Africa, in the middle of June, affected the output for a period of about six weeks. The mill has been running at about two-thirds of its normal capacity since the fire. Ore reserves at West Rand are sufficient for 5½ years of operation at the rate of 850,000 short tons annually. Because of this favorable position, development is being reduced somewhat and sinking of the new South shaft has been deferred.

Wigwam Continues Development. Installation of a small power unit and a 375-cu.ft. Sullivan air compressor has permitted underground work at the property of Wigwam Mining, near Revelstoke, B. C., according to W. T. Dumbleton, engineer in charge of the property. The mineralized zone is said to be 135 ft. wide, with four shoots having an average thickness of 16 ft. carrying silver, lead, and zinc. Drifting is now under way along one of these shoots and the others are being opened through crosscuts and raises.

Quincy Suspends Work for New Five-Week Period

Quincy Mining, one of the smaller copper producers in the Michigan district, has suspended copper production for a period of five weeks, starting Aug. 1. Work in all departments will be resumed on Sept. 8. Only necessary maintenance work will be done during the shutdown. Recently, Quincy shut down for three weeks. When work is resumed in September, the men will be put in a six-day basis. Production at that rate should be about 1,000,000 lb. of copper monthly. Rental of employees' houses will be remitted during the shutdown.

Quincy's two main hoisting shafts—Nos. 2 and 6—are now both equipped to go down 14,000 ft. on the incline. The greatest depth yet reached at this property is 9,200 ft. on the incline. The cost of remodeling No. 6 shaft hoist to permit such deep operations was $102,000. Although an old hoist, it has worked smoothly ever since put in commission again.

In the Quincy mill, four flotation units have now been installed, leaving only one head still to be equipped. This will reduce copper losses in tailing and effect economy in labor. The last complete flotation equipment to be installed was at No. 2 head, as follows: One 24-in., 12-cell flotation machine; one 3x18 ft. Dorr classifier; one 12x7 ft. concentrate Dorr thickener; and three reagent feeders. At No. 1 head, additional equipment installed includes one 3x18 ft. Dorr classifier and seven roughing tables, which replaced six Tamarack separators, 24 two-compartment roughing jigs, and four three-compartment finishing jigs. The old wooden floors and dry-rock walls were replaced with reinforced concrete. Previously, a large No. 86 ball mill was installed in the mill and a large 40x17 ft. diameter Dorr thickener tank placed in a reinforced-concrete addition to the main building.

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Bristol Resumes Development

Development work has been started at the Bristol lead-zinc mine of W. F. Snyder & Sons at Pioche, Nev. No ore is being shipped. The company is drifting to prospect below the old Hillside mine, productive years ago. At the Raymond Ely Extension mine, drilling is being done. Operations at the Combined Metals mine are being confined to development in the vicinity of the Caselton shaft. No work is being done by the Snyder interests in the Comet district.

■

New Connection at Tom Reed

At last report, the connection between a winze from the 700 level and a raise from the 1,100 level of the Tom Reed Gold property, at Oatman, Ariz., had nearly been completed. The new opening is expected to improve the ventilation of the mine materially. Both raise and winze are being driven on the Aztec orebody and thus serve to add to ore reserves as well. In the Grey Eagle section of the mine, a winze has been put down from the 1,100 level to 1,225 ft. At that depth a drift is being driven along a 3-ft. vein.

Tom Reed is now probably the largest gold producer in Arizona and the only dividend-paying gold mine in the state. Only one lease is being operated in the mine at present. It is near the old Stoney shaft.

At the property of Red Lion Gold, which covers the extension of Tom Reed's Grey Eagle vein, new hoisting equipment has been installed. The shaft is 500 ft. deep. Development will be undertaken on the 300 level first.

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Trail Custom Receipts Gain

In spite of depressed metal markets, the custom-ore shipments made to the Trail smelter, in British Columbia, totaled 261 short tons from seven different properties during the period July 22 to 31, according to statement of Consolidated Mining & Smelting. This is the largest number of mines to ship within a comparable period at any time this year. The tonnage is the largest since March, when 357 tons of custom material was shipped between March 22 and 31. In addition to the Bell, Union, and Wellington mines, which have maintained regular shipments of a carload a week to the smelter, the Midnight, Ruth Sally, and Silversmith properties contributed to the shipments. This is the first shipment received from the Midnight, which operates at Rossland.

Receipts of ore and concentrate from the company's mines, chiefly the Sullivan, totaled 12,322 tons.

■

Reopen Elko County (Nev.) Mine

A group of Salt Lake men, headed by C. S. Woodward, have organized Centennial Consolidated Mining to operate the old Hartley property, recently acquired from the Hartley estate. This property is about 1½ miles from the Spruce Monarch property, in the Spruce Mountain district, and about 20 miles from Tobar, Elko County, Nev. It formerly produced a considerable tonnage of high-grade lead-copper silver ore, according to Mr. Woodward. Low-grade material could not be shipped because of lack of adequate transportation facilities.

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Develop Texas Quicksilver Area

P. R. Yewell, of San Antonio, Tex., and associates are developing a quicksilver property east of the producing mines in the Terlingua district of Texas and about two miles north of the Lajitis crossing of the Rio Grande. A total of seventeen claims have been obtained. The new extension of the Santa Fe railroad to Presidio should shorten the truck haul for the Terlingua producers considerably, as soon as a road can be constructed.

■

Work on Yankee Mines Tramway

Construction of the 4-mile cable tramway from the Yankee Mines property, controlled by American Smelting & Refining, in American Fork canyon, 45 miles south of Salt Lake City, Utah, has been begun by the Riblet Tramway Company of Spokane. Work has been begun at the Deer Creek terminal. About forty men are employed. Shipments of gold-copper ore from the mine have been stopped, until the tramway is completed early in the fall.

Mohawk Drift on Evergreen Shows 400 Ft. of Ore.

At 200 ft. on either side of the crosscut, or a total of 400 ft., the Evergreen lode in the Michigan property of Mohawk Mining, in Ontonagon County, Mich., is of as good a grade as it was in the crosscut in which the ore was first disclosed. The lode is about 42 ft. wide in the crosscut. Whether the unusual width continues is not known, as the size of the drift, which is being driven along the footwall, is 8x9 ft. The crosscut to the lode was driven from the No. 15 level, at an inclined depth of 1,740 ft. from surface, the deepest point at which operations have ever been conducted in that section of Ontonagon County.

The copper in the lode is in the form of small mass or nuggets and its persistence is encouraging. The management's aim is to establish continuity of lode and mineralization in an effort to dispel the bugaboo that Ontonagon County formations are badly cut or faulted. It has the advantage of greater depth than that at which lodes have been previously opened in that area, the management having deepened "E" shaft more than 800 ft. to get into what it believed would be more regular, settled ground. Continuity of lode and grade to date strengthen the hope that the formation will continue regular and well mineralized. It is still regarded in the light of a development, but a most satisfactory one from every point of view so far.

At the Mohawk mine, in Keweenaw County, Mich., No. 1 shaft continues in operation, although remaining ground is limited. A few blocks of copper rock, including portions of shaft and floor pillars, are still to be mined. No. 1 is furnishing less than 25 per cent of the tonnage going to the stamp mill. No. 6 shaft continues in rich ground, mineralization comparing favorably with that shown last year.

■

Develop Blue-Eyed Maggie

Dr. E. R. Northrup, of Spokane, Wash., has taken over the Blue-Eyed Maggie mine, in the Emery district, near Deer Lodge, Mont. The property has been shipping high-grade gold-silver ore. New machinery is being installed, and the shaft will be deepened under the direction of James Higgins, manager, and W. A. Williams, engineer. The line of the Montana Power Company is being extended to the property.

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Geological Mapping in Montana

Dr. C. H. Clapp and party are completing the geological survey of the Cooper's Lake quadrangle in Montana. Russell Gibson is completing the survey of the Libby quadrangle and J. T. Pardee, of the U.S.G.S., will complete a study of the Pioneer placer district, which he began several years ago. The Princeton geological department is again working in the Red Lodge region, and Dr. Parker is studying the geology and coal resources of Custer and Powder River counties, while Arthur Collier's party is mapping eastern Montana to get information for a complete geological map of that part of the state on a scale of 1 to 500,000.

Vanadium-Unit Operations of Rhodesia Broken to Continue

By Special Cable to "E.&M.J."

London, July 31.—At the annual meeting of Rhodesia Broken Hill Development, Sir Edmund Davis, chairman of the board of directors of the company, stated that the reason the zinc plant was closed was that costs were about £18 per long ton of metal, compared with a market that was about £12 per ton. In addition, consumption outside the United States in 1931 could not be estimated at more than 650,000 long tons, compared with 882,000 tons in 1930. The restriction scheme for a curtailment of 45 per cent in output was to go into force in August, Sir Edmund pointed out, and might be expected to improve the situation. Production of vanadic acid from the vanadium unit, which will continue in operation at the property, at Broken Hill, Northern Rhodesia, is now 25 long tons monthly. The company intends increasing production to 100 tons of concentrate monthly. A market has been arranged for the product in Germany and France at a price sufficient to insure maintenance of the plant and a small profit.

. . . . Commonwealth Mines Preliminary Syndicate, an English group operating gold properties in northern Queensland, reports that on its Percyville Tunnel claim, a shaft cut ore at a depth of 13 ft. It is 2 ft. 6 in. wide and assays 8.19 dwt. in gold and 5 oz. of silver per ton. On the Percy Queen claim, the work of clearing an old shaft has shown ore that assays 1 oz. 17 dwt. in gold per ton.

. . . . Tigon Mining & Finance announces that results of operations of its Spanish treatment plant to date have not proved sufficiently satisfactory to warrant extension. Further work on the plant has been suspended. A unit of four furnaces of an improved Gill type had been installed, and a second was under construction. This was to provide for the Spanish market. Stocks of refined sulphur in Chile are regarded as sufficient and production there is being curtailed. The Chilean property is in the Tacora district, near Arica. Although potential reserves are large, operations are on a small scale.

. . . . Ex-Lands Nigeria output for 1930 was 495 tons of concentrate averaging 72.5 per cent metallic tin. Average price realized for concentrate after deducting freight, royalty, and realization charges was £88 12s. 9d. per ton, as compared with £123 7s. 2d. in 1929. Net costs f.o.r. Bukuru, were £52 10s. 1d., against £62 19s. 9d. Ore reserves proved at the end of 1930 were 3,582 tons, and partly proved 3,965 tons; the loss for the year was £2,626.

. . . . A severe rockburst has occurred in the Edgar's shaft of Mysore Gold, in the Kolar district, India, and pillars have been extensively damaged from Nos. 32 to 45 levels. The output will be affected. It is usually about 15,000 tons of ore a month.

. . . . Mines de Villemagne, silver-lead-zinc operator in the south of France, had reserves of 389,000 metric tons of ore, averaging about 10 per cent lead and zinc combined, at the end of 1930. During that year 155,000 wet tons of ore was extracted and 969 m. of development work was undertaken. The reserves show an increase in volume and grade over those in sight at the end of 1929. Development on the 809 level along the Etoile Blanche lode has been particularly satisfactory. Production has been reduced to 7,000 metric tons of high-grade ore monthly, or about 50 per cent of the normal tonnage.

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Union Corp. Options Holdings of Marievale Nigel

By Special Cable to "E.&M.J."

Johannesburg, July 31.—Union Corporation, mining-finance house which controls Geduld Mines, East Geduld, and other gold properties in Transvaal, has taken an option on the holdings of Marievale Nigel Gold Mines & Estate, lying southeast of the Witwatersrand. The company intends to start preliminary development of the property almost immediately. The holdings include ground on the farms Draaikraal and Holgatfontein. Although formed in 1895, Marievale Nigel has done virtually no work since 1897. Recent developments in Far East Rand and the Sub Nigel properties make the territory of considerable interest.

. . . . The report is widespread that Alfred James, who is now here, is to institute litigation against certain Rand gold mines for alleged infringement of cyanide patents. No definite word on this litigation is obtainable, however.

. . . . Increased interest in gold may lead to the reopening of some of the properties in the Klerksdorp district, 100 miles southwest of Johannesburg. In particular, the Southleigh property is likely to be put into condition for production once more. At one time there was great prospecting activity in this district, with not fewer than seventeen companies in operation. At present only one property is producing—the Afrikander. About 180 tons of ore is treated daily, the grade being £1 a ton.

. . . . South African base-metal properties have nearly all suspended production. The latest to close is Rooiberg Minerals, which operates a tin mine in the Transvaal. In 1930, the company produced 425 long tons of concentrate, averaging 65.7 per cent tin. The final shipment of copper has been affected from Namaqualand, where Namaqua Copper recently closed down until copper prices improve. Employees at the Tsumeb lead-copper mines of Otavi Mines & Railway are accepting reduced salaries to prevent a shutdown. (A report from our Berlin correspondent, published last month, stated that the mine had actually been closed.—Editor.)

. . . . Sessions of the Low-Grade Gold Ore Commission of the government of the Union of South Africa are to be resumed at Johannesburg. Important evidence has already been collected on the quantities of low-grade material available on the Witwatersrand and the effects of cost reductions on the possible exploitation of these tonnages. At Gatooma, in Southern Rhodesia, a new mining association has been formed as the result of a recent conference, with the object of stimulating the mining industry.

Williams Discusses Katanga and Kansanshi at Meeting

By Special Cable to "E.&M.J."

London, Aug. 1.—At the annual meeting of Tanganyika Concessions, Ltd., held here on July 29, Sir Robert Williams, chairman of the board of directors of the company, stated that the stocks of copper held by Union Minière du Haut-Katanga, in which Tanganyika has a large interest, are not excessive. Owing to the depression the output is now being limited to 10,000 metric tons of copper monthly, but the intimation was made that actual capacity is 200,000 tons annually. The western mines of the company, known sometimes as the Musonoi group, will probably be equipped to produce an additional 60,000 metric tons annually. At present, all work on these properties has been suspended. Arrangements have been made by the company to ship 4,000 metric tons of copper monthly by the new Lobito Bay route, which cuts costs and distance considerably.

. . . . At the Kansanshi mine of Rhodesia Katanga, in Northern Rhodesia, which Tanganyika controls, only drilling work is now being done. Plans are being drawn up for the metallurgical plant that will probably be erected at this property. Capacity will be 50,000 tons of copper a year, but no especial effort is being made to put this deposit into production at an early date.

. . . . The Tanganyika report for 1930 exhibits a poor showing, the profits being practically halved at £232,865. No dividend is being paid on the ordinary capital, as the profit on sale of shares is only £33,312, compared with £264,200 in the preceding year. The company is mainly dependent upon the results achieved by the Union Minière, and its interest from this source has been reduced.

. . . . The third unit of the new Roan Antelope concentrator is now reported to be in operation, making the daily tonnage treated by the plant, the first of the large-scale producers in Northern Rhodesia, more than 3,000 short tons. Estimates are heard that the cost of copper production, before depreciation or interest, is down to 7c. a pound of copper. This reduction from the original estimate of 8c. a pound is due to the lower freight rates and coal costs that have been assured since production started in May.

. . . . A. D. Wilkinson, who will be in charge of the Rhokana smelter, at the N'Kana mine, in Northern Rhodesia, is now in London.

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Nickel in Tanganyika

Toronto.—Prospecting rights over an area of 1,300 square miles in Tanganyika, East Africa, have been granted to Ventures, Ltd., and Falconbridge Nickel, Canadian mining companies, according to the *Northern Miner*. Several nickel discoveries have been made in the area, which is near Dodoma, but their importance cannot be determined without further prospecting. Falconbridge Nickel is now producing nickel and copper from its mine in the Sudbury district, its nickel production being exceeded only by International Nickel and Caledonickel, the leading French producer in New Caledonia. Both Falconbridge and Ventures are controlled by the Thayer Lindsley interests, of Toronto.

MARKET AND FINANCIAL NEWS

Credit Situation Restricts German Metal Buying

DR. JAMES RUBINFELD
BERLIN

The crash of the Darmstädter und Nationalbank, of Berlin, has made traders distrustful of the whole credit structure of Germany, and the flurry in business that followed the first Hoover announcement has come to a sudden halt. The Berlin bank was an important factor in financing paper in connection with foreign trade in raw materials. In Germany the business situation is expected to remain uncertain and extremely delicate, pending a final readjustment of foreign credits.

Germany purchased about 30,000 metric tons of copper in the period of June 21 to July 5, and fully two-thirds of this quantity was absorbed by a few big consumers — Siemens, Vereinigte Deutsche Metallwerke, Hirsch Kupfer und Messingwerke, and Cologne cable works of Felten Guilleaume. Most of the copper bought on the "Hoover boom" was for delivery over the next three months. Operators in copper believe that about half of the total quantity purchased will be delivered from the big stocks piled up in Germany by selling agencies. The increase in German imports during the first five months of this year is attributed in some quarters to the desire of producers to distribute their holdings of copper.

At prevailing price of copper, Mansfeld Copper, Eisleben, is operating at a loss of about ten million marks a year. In spite of the subvention from the Reich and Prussia, the company is negotiating for another cut in wages.

In regard to the renewal of the Brussels Zinc Cartel, the speed with which an agreement was reached with representatives of the Consolidated Mining & Smelting Corporation of Canada astonished most of those present at the gathering. Consent of the French-Spanish group was obtained only after several days. Production of zinc outside of the United States is to be reduced to about 50,000 tons a month, according to the agreement, and European consumption is down to not more than 60,000 tons. Normal consumption would be nearer 100,000 tons a month. The reduced rate of production should make some inroads on world stocks, now estimated at 250,000 metric tons.

The Société Minière et Métallurgique de Peñarroya reports that ore prospecting in Yugoslavia has resulted in nothing of special interest. In 1930 the company mined 49,300 tons of lead ore from its Spanish holdings, against 56,300 tons in 1929. With the exception of the mine Nava de Rio Frio, all development work has been sharply curtailed. At Djebel Ressas, in northern Africa, the existence of a rich orebody has been verified, but development work will not be started until business conditions improve.

Italian lead production is to be stimulated through a higher import tariff. The duty has been raised to 120 lire. The old rate was 110 lire. Italian production of lead in 1930 amounted to 24,411 tons, against 22,665 tons in 1929. Lead production for the first five months of the current year amounted to 10,185 tons, against 9,643 tons in the same period last year. Consumption in Italy last year was estimated at 42,400 tons, against 47,300 tons in 1929.

Germany imported 47,578 metric tons of manganese ore in the first five months of the current year, against 182,303 metric tons in the same period last year.

E.&M.J. Weighted Index of Non-Ferrous Metal Prices

100 Is Composite for 1922-3-4

1920	130.92
1921	80.80
1922	93.94
1923	103.43
1924	102.63
1925	111.74
1926	107.74
1927	97.54
1928	99.78
1929	110.33
1930	82.87

	1929	1930	1931
January	106.86	102.94	67.62
February	110.37	102.28	65.90
March	122.71	99.93	68.03
April	116.36	93.24	64.45
May	110.03	83.41	59.81
June	109.66	78.57	58.23
July	109.58	74.58	59.54
August	109.81	74.41	....
September	109.29	73.42	....
October	108.52	69.63	....
November	106.09	71.39	....
December	104.75	70.65	....

International Nickel Lowers Dividend Rate

The International Nickel Company of Canada has declared a quarterly dividend of 10c. a share on common stock. This places the stock on a 40c. annual basis, against 60c. previously.

The directors issued the following statement:

"While the management believes that the company's business will show improvement during the last half of this year, there is at present a restricted demand for nickel due to drastic curtailment in the steel and automobile industries. Because of the uncertainty of industrial conditions, coupled with the current cash expenditures which will fully complete the construction program by the end of this year, the board of directors decided it to be in the best interest of stockholders to conserve the company's strong cash position. Many plant economies have already been effected, and with the completion of plant construction further reduction in production costs will be promptly realized."

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Quarterly Reports

HOWE SOUND, operating properties in Canada, the United States, and Mexico, reports a net income of $127,467 in the second quarter of 1931, compared with $319,698 in the first quarter. The company produced metals valued at $2,128,082 at a profit, before depreciation of $254,277, in the second quarter. Production in the first quarter, valued at $2,704,720, was higher in all metals.

CALUMET & HECLA CONSOLIDATED COPPER reports for the quarter ended June 30, 1931, a loss of $363,868 after taxes, depreciation, and other charges, but before depletion. This compares with a loss of $381,355 in the preceding quarter, and a profit of $156,085 in the June quarter of last year. The net loss after depletion for the June quarter of this year amounted to $583,[illegible]47, against a net loss of $735,474 in the preceding quarterly period.

AMERICAN METAL COMPANY reports for the June quarter a net loss of $211,344, after depreciation, interest, taxes, and other charges, against a profit of $108,392 in the preceding quarter, and a profit of $499,227 in the June quarter of last year.

Copper Curtailment—In and Out of the U. S.

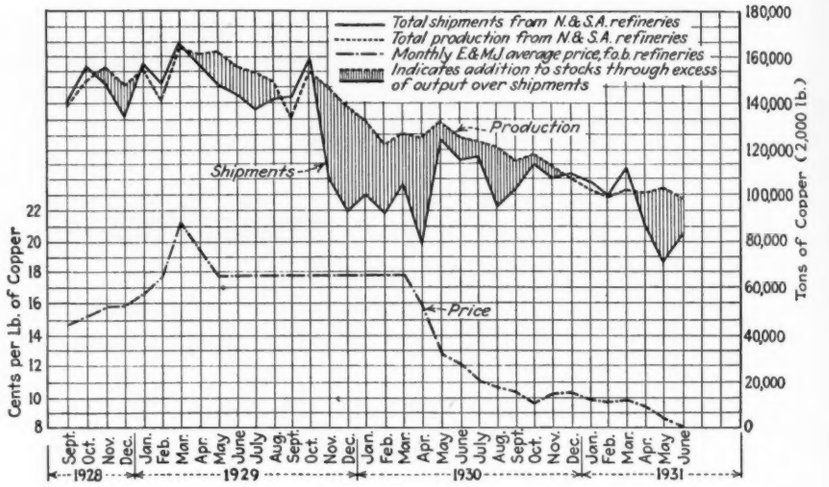
S. D. Strauss,
Assistant Editor

The copper producers of the world, gathered in solemn conclave last November, agreed to a reduction in output of about 23,000 tons of copper a month. This agreement, which promised to distribute the burden of curtailment among all the world's large mines, was hailed as a constructive step in a demoralized market. Up to last November, the United States had borne the brunt of the burden of curtailment. The agreement brought hope of cooperation from Africa and Canada.

Examination of statics, after sufficient time to warrant conclusions has elapsed, is always an instructive process. What has happened to the copper curtailment plan? In October, 1930, the last month before it went into effect, world production of blister copper was put at 157,344 short tons by the A.B.M.S. In June production was 126,722 tons. The difference in the length of the two months makes the actual reduction slightly less than the 30,600 tons indicated. Nevertheless, the agreement apparently has been maintained. Of course, some copper producers held hopes that small mines, not included in the agreement, would by now have been forced to close and would thereby still further reduce output. That hope has been only partially fulfilled.

Consultation of A.B.M.S. figures to determine the extent of curtailment in individual countries is likely to be deceiving. At first glance, the inquirer would assume that the United States again bore the brunt of the burden, for its drop in output, as recorded by the A.B.M.S., was no less than 18,767 tons, or 26 per cent. compared with the total world reduction of 19 per cent. As the United States, previous to the November agreement, had been the leader in the curtailment put into effect in the winter of 1929-1930, these figures apparently justify the widespread impression that it is the chief sufferer in the reduction of copper output.

This attitude overlooks the fact, however, that A.B.M.S. monthly figures are for smelter output, without reference to the country of origin of ore. The United States, in addition to being the largest mine producer of copper, is the largest importer of ore and concentrate for smelting. United States mine output in October was only 55,954 tons, as shown in the accompanying table. In June it was 44,647 tons. Although smelter production did drop 26 per cent, mine output dropped only 20 per cent. Assuming that the rest of the smelter output of the world can be credited to foreign mines, October mine output outside the United States can be estimated at 101,000 tons of copper and the June output at 82,000 tons—a reduction of 19 per cent.



World Smelter Output

	Short Tons
October, 1930	157,344
June, 1931	126,722
Reduction	30,622
Reduction, per cent	19

U. S. Smelter Output

October, 1930	70,419
June, 1931	51,652
Reduction	18,767
Reduction, per cent	26

Foreign Smelter Output

October, 1930	86,825
June, 1931	75,070
Reduction	11,755
Reduction, per cent	14

U. S. Mine Output

October, 1930	55,954
June, 1931	44,647
Reduction	11,307
Reduction, per cent	20

Foreign Mine Output(a)

October, 1930	101,390
June, 1931	82,075
Reduction	19,315
Reduction, per cent	19

(a) These figures are obtained by deducting U. S. mine output from world smelter production, and assuming that the remainder represents foreign-mine output. The time required in smelting and in transportation of ore and concentrate to smelters makes this a slightly inaccurate method, but it is the only available means of obtaining the figures.

The reason for the apparently greater curtailment of foreign mine output than of foreign smelter output is apparent to one familiar with the copper market. United States copper producers own properties or are affiliated with companies operating in other countries that ship ore and concentrates to American smelters. Such important mines as Moctezuma, Britannia, Allenby, and Matahambre supply charge for domestic plants. They have reduced output as much as or possibly more than most mines, either here or abroad, and the drop in their shipments has been reflected in American blister figures.

In the accompanying chart the total production of refineries, both in North and South America, is compared with their shipments and the average price of copper, month by month, since September, 1928, when the copper boom was getting under way. The chart makes clear the absurdity of applying economic principles, such as "supply and demand," without first considering the characteristics of the industry to which they are applied. Copper production reached a peak in March, 1929. Although the price continued to be about 4c. above the normal post-war level of 14c. a pound, production declined. Pure economic theory, of course, is that output increases and demand decreases with high prices. The second half of the theory, alas, was all too true.

As a result, the price was cut in April, 1930, with the idea of restricting production and stimulating consumption. In the period that has elapsed since then, output has declined less than in the previous twelve months when the price was high. Consumption, after a temporary revival, has gradually dropped off owing to the widespread industrial depression. Sooner or later, the major tenet of increased demand at low prices should come true. The question is when.

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Union Minière's 1930 Report

Operating profit of Union Minière du Haut-Katanga, Belgian Congo copper producer, was 354,756,570 fr. in 1930, compared with 475,681,443 fr. in 1929. After interest and depreciation, 1930 earnings were 270,207,989 fr., compared with 276,340,924 fr. in 1929. In the former year, 100,895,066 fr. was allocated to reserve funds. The company does not state the total value of its output. Total assets at the end of 1930 were 2,234,537,022 fr. Of this, 175,013,313 fr. was cash, 649,875,120 fr. was stocks of ore and metal, 242,910,690 fr. was accounts receivable, and 182,389,669 fr. was investments. The company has reserves of 259,853,379 fr., accounts payable of 614,732,519 fr., and outstanding notes of 544,900,000 fr.

Production was 138,949 metric tons of copper, compared with 136,992 in the previous year. The tonnage of ore treated was 2,603,000 metric tons, compared with 2,225,000.

U. S. Feldspar Production Reduced During 1930

Crude feldspar sold or used by producers in the United States in 1930 amounted to about 171,788 long tons, valued at $1,066,636, or $6.21 a ton, according to the U. S. Bureau of Mines. These figures show a decrease of 13 per cent in quantity and 16 per cent in total value in comparison with those for 1929. Feldspar was reported as having been mined and sold in 1930 in 10 states—namely, California, Colorado, Connecticut, Maine, New Hampshire, New York, North Carolina, Pennsylvania, South Dakota, and Virginia. The greatest feldspar-producing region is that which includes the Atlantic seaboard states, from Maine to North Carolina. This region reported about 91 per cent of the total output in 1930. North Carolina, the leading producer, reported 60 per cent of the total output; Maine, second, reported 13 per cent; and New Hampshire was third with 10 per cent. The average value per long ton in North Carolina was $5.75; in Maine, $7.11; and in New Hampshire, $8.01.

Except for minor purposes, feldspar is prepared for use by grinding. This work is done principally by commercial mills. Only a very small portion is ground by users in their own mills. In 1930 there were 34 commercial mills operating in 12 states: California, Colorado, Illinois, Maine, New Hampshire, New Jersey, New York, North Carolina, Ohio, South Dakota, Tennessee, and Virginia. These mills reported 181,541 short tons of ground feldspar sold in 1930, valued at $2,450,915, or $13.50 a ton, compared with 230,582 tons, valued at $3,296,252, or $14.30 a ton, in 1929, a decrease of 21 per cent in quantity and of 26 per cent in total value. Of the quantity of ground spar sold in 1930, 167,380 short tons, valued at $2,167,352 (or $12.95 a ton), was domestic feldspar, and 14,161 tons, valued at $283,563 (or $20.02 a ton), was imported feldspar. Imported feldspar was ground in two states in 1929—New York and Ohio. These figures represent a large decrease in imported feldspar ground as compared with 1929.

The production of crude feldspar by states in 1929 and 1930 is shown in the accompanying table.

Crude Feldspar Sold or Used by Producers in the United States in 1929 and 1930

State	1929 Long Tons	1929 Value (a)	1930 Long Tons	1930 Value (a)
Arizona	(b)	(b)	.....	.....
California	12,770	$84,567	6,519	$54,941
Colorado	(b)	(b)	1,933	10,575
Connecticut	2,726	21,056	(b)	(b)
Maine	19,992	142,042	22,738	161,631
Maryland	2,624	19,610	.....	.....
New Hampshire	30,964	231,810	16,517	132,342
New York	12,696	103,531	5,556	37,790
North Carolina	103,273	598,938	103,163	593,552
Pennsylvania	(b)	(b)	(b)	(b)
South Dakota	(b)	(b)	(b)	(b)
Virginia	6,677	38,628	6,760	38,048
Undistributed	5,977	36,458	8,602	37,757
	197,699	1,276,640	171,788	1,066,636

(a) Value at mine or nearest shipping point. (b) Included under "Undistributed."

Mining Company Dividends for July, 1931

Companies in the United States	Situation	Per Share	Total Disbursements
Aluminum Company of America, pfd	Various	$1.50Q	$2,214,930
Bunker Hill & Sullivan, pfd., l, s	Idaho	2.00QX	15,958
Castle Peak Quicksilver	Nevada	0.50Q	10,000
Cresson Consolidated, g	Colorado	0.01Q	12,000
Granite Gold	Colorado	0.01	16,005
Homestake Mining, g	South Dakota	0.50M	125,580
Kennecott Copper	Various	0.25Q	2,343,031
Magma Copper	Arizona	0.25Q	102,039
Phelps Dodge, c	Various	0.25Q	705,635
Tom Reed Gold Mines	Arizona	0.03Q	60,000
U. S. Smelting, Refining & Mining	Various	0.25Q	121,587
U. S. Smelting, Refining & Mining, pfd	Various	0.875	425,557
Companies in Other Countries			
Consolidated Mining & Smelting, l, z, s	Canada	1.25SAS	670,230
Dome Mines, g	Canada	0.25Q	238,333
Hollinger Consolidated Gold	Canada	0.05M	246,000
Howe Sound, c, l, z	Canada, Mexico	0.50Q	248,020
New York & Hunduras Rosario, s, g	.....	0.25Q	50,000
Lucky Tiger-Combination Gold, s	Mexico	0.03	21,460
Pioneer Gold	Canada	0.03Q	50,000
Premier Gold	Canada	0.03Q	150,000
*Wright Hargreaves, g	Canada	0.05Q	275,000
Total			$8,101,365

c, copper; s, silver; l, lead; g, gold; z, zinc; Q, quarterly; M, monthly; SAS, semi-annual, includes 5 per cent stock divided; X, extra. *Paid on June 30, omitted from June list.

Financial Notes

COMPAGNIE HUANCHACA DE BOLIVIE, operating a zinc-silver mine, reports a net loss, after all charges, of £36,280 in 1930, compared with a loss of £40,629 in 1929. Operating profit was £21,617. The company has total assets of £2,134,205. The most important liability is a debt of £322,386 to Mauricio Hochschild & Cie. Production in 1930 was 2,792,387 oz. of silver, 8,580 metric tons of zinc concentrate, and 7,070 tons of lead concentrate.

COMPAGNIE MINIÈRE DU M'ZAITA is floating a bond issue of 30,000,000 fr., carrying 5 per cent interest and payable in 1958. It will be convertible into common stock at the rate of four shares for every 500 fr. of bonds held at any time before 1936. The company has an important phosphate property in Morocco and owns the Chagres copper deposits in Chile. Both are closed down at present. The financing is to permit the company to weather the depression and meet obligations.

MINES ET USINES À ZINC DE SILESIE, French-controlled zinc producer in Poland, reports an operating loss of 2,607,967 zloty in 1930, compared with a profit of 2,547,536 zloty in 1929. Production of zinc was higher than in 1929, amounting to 63,648 metric tons of slab, 2,454 tons of electrolytic, and 15,376 tons of zinc dust.

World Lead Production Shows Little Change

World production of lead during June amounted to 120,240 tons, against 123,639 tons in May, and 150,541 tons in June, 1930. The daily rate for June was 4,088 tons, against 3,988 tons in the preceding month. Production, by countries, for April, May, and June, according to the American Bureau of Metal Statistics, in tons, follows:

	April	May	June
United States	35,498	39,519	30,708
Canada	13,336	11,345	11,262
Mexico	22,207	18,426	21,093
Peru	.....	.....	.....
Germany	8,591	7,918	10,097
Italy	2,136	2,302	1,941
Spain and Tunis	9,253	7,102	7,987
Europe(a)	17,500	16,000	16,100
Australia	14,533	13,129	13,037
Burma	7,672	6,698	6,815
Elsewhere(b)	1,200	1,200	1,200
Totals	131,926	123,639	120,240

(a) Not elsewhere specified. (b) Estimated or partly estimated.

Receipts of domestic lead ore by United States smelters during June amounted to 32,551 tons, against 35,677 tons in May, and 47,692 tons in June, 1930, according to the American Bureau of Metal Statistics. The intake of lead in ore in June was the lowest monthly total reported since the beginning of the business depression.

Receipts of lead in ore in the first six months of 1931, in tons, follow:

	Domestic	Foreign	Total
January	42,110	2,202	44,312
February	35,512	1,232	36,744
March	37,878	1,278	39,156
April	34,694	1,030	35,724
May	35,677	690	36,367
June	32,551	434	32,985

Receipts of lead in ore are computed on the basis of recoverable lead. These monthly totals probably underrun the actual production of pig lead.

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ST. JOSEPH LEAD COMPANY, lead and zinc producer operating in Missouri, Montana, New York, and Argentina, reports a net loss for the six months ended June 30 of the current year of $983,669, against a profit of $2,025,825 in the same period last year.

U. S. Consumes Half of World's Tin Output

Tin is the only metal of which the United States annually consumes more than $20,000,000 worth and yet remains a negligible producer, according to the U. S. Bureau of Mines. In fact, the value of the tin annually imported for consumption ranges from $60,000,000 to $100,000,000 and accounts for almost half of the world production. Annual domestic production is valued at less than $50,000.

The principal tin-consuming industries are food packing, automobile manufacture, and building. The packing of food is relatively stable from year to year and may be counted upon to absorb a fairly constant quantity of tin plate and solder, but the automobile industry is subject to wide variation in the number of units produced, says Charles White Merrill, in a Bureau of Mines report.

If the recovery of secondary tin—that is, the production of tin from sources other than ore—were included with primary production, the United States would rank third among the tin-producing countries of the world. Tin-bearing alloys, tin-plate clippings, and melting-pot drosses are the most important materials from which tin is reclaimed. Most of the tin recovered from alloys does not pass through a refined-tin stage but is made into alloys which are brought to the required specifications by the addition of virgin metals.

Most of the tin plate entering the reclaiming processes consists of trimmings incidental to the fabrication of tin-plate products. In the past some used tin cans have entered the detinning plants, but at present prices for reclaimed metals the recovery of tin from this source is unprofitable in the United States.

Tin concentrates were first imported for smelting in the United States in 1915, reached the high point both in quantity and value in 1920, and virtually ceased in 1924. The enormous local market, coupled with the proximity of Bolivia, should allow the United States to build up a large tin-smelting industry if a process for handling Bolivian concentrates economically, without the admixture of clean ore, could be devised.

The widespread opinion that the reserves of tin, marketable at about current prices, are very limited, encouraged for many years research for substitutes. The relatively high price of tin in comparison with that of most of the common metals proved an added incentive to substitution.

Much study has been given to the problem of finding a substitute for tin plate in the canning industry, but no tin-free container has been developed as yet that can offer serious competition to the tin can. Glass containers have been used successfully where the advantage of display of contents has outweighed the higher initial cost and the difficulties of transportation. Experiments have been made with stainless steel cans, but the high cost and difficulties of opening have made their use uneconomical. Research to develop a practical aluminum can continues. Research in the substitution of lacquers for tin in the manufacture of tin cans has made little progress because of the difficulty in obtaining an appearance of cleanliness and beauty equal to that of the tin as well as the difficulty in duplicating the purely utilitarian qualities of the tin coating.

In the manufacturing of alloys the aluminum brasses have displaced some of the tin-bearing bronzes.

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Calumet & Arizona Mining

Calumet & Arizona Mining Company, in the six months ended June 30, 1931, reports a net profit of $153,675 after depreciation and taxes, but before depletion. This compares with $1,415,065 in the first half of 1930.

Net profit for the June quarter was $78,042 after depreciation and taxes, but before depletion, comparing with net profit of $75,633 in the preceding quarter. In the June quarter of last year the company reported a profit of $844,781 before depreciation, depletion, and federal taxes.

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Patiño Mines & Enterprises

Patiño Mines & Enterprises, Bolivian tin producer, reports for the six months ended June 30, 1931, a net loss of $471,106 after interest, depreciation, depletion, and other charges, comparing with a net loss of $338,011 in the first half of 1930.

Net loss for the June quarter amounted to $307,488 after the charges mentioned in the foregoing, against a net loss of $163,618 in the preceding quarter, and net loss of $488,580 in June quarter of last year.

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Financial Notes

EAGLE-PICHER LEAD COMPANY reports for the six months ended June 30, 1931, net loss of $316,002 after depreciation, depletion, inventory adjustments, and other charges, against a net loss of $836,412 in the first half of 1930.

GRANBY CONSOLIDATED, operating a copper mine in Canada, reports a profit of $7,405, before depreciation or depletion, in the second quarter of 1931. In the first quarter, profit was $170,078. Production was virtually unchanged at 8,395,107 lb. of copper, entirely from the Anyox unit. Production cost was 8.078c. a pound of copper.

TEXAS GULF SULPHUR, operating sulphur properties in Texas, reports net income, after depreciation, of $1,939,967 in the second quarter of 1931. In the first quarter, it was $2,448,198.

AMERICAN ZINC, LEAD & SMELTING, zinc producer in Tennessee and Illinois, reports net profit, after depreciation and depletion, of $152,466 in the second quarter of 1931. This compares with $103,564 in the first quarter. For the first half of 1931, earnings were $256,030, compared with $253,179 in the same period of 1930.

Production of Gold and Silver in the United States

The U. S. Bureau of the Mint, with the cooperation of the Bureau of Mines, has issued the following statement of the final estimate of refinery production of gold and silver in the United States during the calendar year 1930:

States	Gold		Silver	
	Ounces	Value	Ounces	Value(a)
Alaska	407,356	$8,420,800	392,024	$150,929
Alabama	10	200	.....	.....
Arizona	148,681	3,073,500	4,910,394	1,890,502
California	450,289	9,308,300	1,434,126	552,139
Colorado	218,258	4,511,800	4,851,571	1,867,855
Georgia	203	4,200	23	9
Idaho	21,198	438,200	9,710,150	3,738,408
Illinois	.....	.....	1,896	730
Michigan	.....	.....	10,720	4,127
Missouri	.....	.....	187,548	72,206
Montana	46,900	969,500	8,596,966	3,309,832
Nevada	140,220	2,898,600	4,178,943	1,608,893
New Mexico	31,589	653,000	1,160,374	446,744
North Carolina	498	10,300	32,891	12,663
Oregon	14,300	295,600	9,816	3,779
Pennsylvania	610	12,600	4,538	1,747
South Dakota	406,297	8,398,900	105,166	40,489
Tennessee	721	14,900	85,533	32,930
Texas	242	5,000	468,736	180,463
Utah	208,936	4,319,100	14,451,266	5,563,738
Vermont	.....	.....	4,512	1,737
Washington	3,647	75,400	29,853	11,493
Wyoming	440	9,100	197	76
Philippine Islands	185,208	3,828,600	120,884	46,540
Totals	2,285,603	47,247,600	50,748,127	19,538,029

(a) Value at 38.5c. per ounce, the average New York price of bar silver.

Comparison with 1929 production indicates an increase in 1930 of $1,596,200 in gold and a decrease of 10,579,741 oz. in silver. In 1915, the year of greatest production, gold output was valued at $101,035,700; silver output in that year was 74,961,075 oz.

Copper Down to New Low of 7.50c. in Dull Market—Lead and Zinc Steady

New York, Aug. 6, 1931.—Business remained quiet, the volume of sales in all of the major metals being far below normal. Copper dropped off in price to 7.50c., delivered Connecticut, a new all-time low, on realization that the continued increase in stocks has not yet been arrested. Lead ruled steady in the absence of any selling pressure, producers apparently being satisfied with the statistical outlook. Zinc was a shade lower, but the undertone was firm on favorable July statistics. Silver and tin showed little change. Quicksilver declined on freer offerings of domestic material, with offers as low as $82 per flask. The *E.&M.J.* weighted index of non-ferrous metal prices advanced slightly in July to 59.54, compared with the year's low of 58.23 in June, thanks to higher monthly average prices for lead, silver, zinc, and tin.

Copper Unsettled

Trading in copper was dull. The price fell to 7¾c. in the first week of the period under review; in the second week of the fortnight the metal sold down to 7½c., delivered. Sales were made at that figure on July 30 for the first time, and a limited amount of business has been done at that price every day since, for various deliveries from prompt to January. On the other hand, subsidiaries of the large producing groups, whose products sold until Aug. 4 on the 8c. basis, bought copper at the full 8c. level, and custom smelters did a small amount of business at both 7¾ and 7⅞c. on various days. In general the amount of copper available at 7½c. is very limited and sellers are trying to confine business at that level to comparatively near-by shipment. As the custom smelters alone are now sharing in the export sales, a little less than 1,000 tons a day being apportioned to them for sale, it is hoped that foreign demand will be sufficient to take the pressure off the domestic market. Export business has not been active recently. July's total was only 17,500 long tons, and the first five days in August have brought in only 2,600.

The export price was dropped from 8.25c. to an even 8c., c.i.f., on Tuesday, Aug. 4, but the large producers are, for the time being, unwilling to sell on that price basis, or its equivalent of 7¾c. in the domestic market. Rumors of efforts to finance German purchases at current prices are discredited.

Another large increase in refined stocks is prophesied for the end of July, perhaps 30,000 tons, owing to decreased shipments, with no appreciable change in production. So long as this continues an improvement in the copper market is hopeless. Whether all of the large copper producers are financially able to continue production and accumulate copper below 8c. remains to be seen. According to opinion in the trade it becomes more and more plain that a complete cessation of operations by a liberal proportion of the producers is needed to right the situation.

Prices of copper products were reduced on Aug. 4 to accord with a 7¾c. copper market, instead of 8c. as before, even though affiliated producers were unwilling to sell copper at that price.

Lead Prices Hold

Despite the quiet prevailing in lead, prices continued steady in all directions. In New York the market held at 4.40c., the contract price of the American Smelting & Refining Company, with St. Louis unchanged at 4.225c. Most of the moderate tonnage sold during the period was for August shipment. Corroders have been taking a fair tonnage, indicating that white lead business must be holding up well for this season of the year. Battery manufacturers are purchasing more lead at this time than automobile operations would seem to warrant, which is explained by the volume of replacement business. Cable manufacturers appear to be going along at about the same rate as earlier in the year.

The steadiness in lead prices reflects the gradual improvement in the statistical position of the metal. Sales of virgin lead for July shipment totaled slightly more than 40,000 tons. The quantity already sold for August shipment is in excess of 30,000 tons. July's statistics are expected to reveal a further shrinkage in production, and, with shipments higher than in the preceding month, stocks will no doubt decline to a greater extent than in June.

Zinc Statistics Favorable

The feature in the zinc market was the decline in stocks registered during July. According to the American Zinc Institute, production for the month of July fell to 21,365 tons, against 23,483 tons in June, 25,688 tons in May, and 40,023 tons in July last year. Stocks at the close of the month were 131,833 tons, against 138,928 tons a month previous, and 143,049 tons in May. Shipments in July totaled 28,460 tons, against 27,604 tons in June, and the low of 25,851 tons in May. Though business was quiet in the last two weeks, prices held fairly steady, settling at 3.85c. for prompt and near-by, with a premium on last-quarter business. What buying interest did exist was chiefly in forward zinc.

Average Metal Prices for July, 1931

COPPER:	
Electrolytic, refinery	7.698
London Standard Spot	34.402
London Electrolytic, Bid	37.293
LEAD:	
New York	4.400
St. Louis	4.225
London Spot	12.731
London Forward	12.899
SILVER:	
New York	28.255
London	13.197
Sterling Exchange	485.425
ZINC:	
St. Louis	3.893
London Spot	12.280
London Forward	12.802
TIN:	
Straits	24.978
London Standard Spot	111.478
QUICKSILVER	85.808
ANTIMONY	6.802
PLATINUM, Refined	40.000
CADMIUM	55.000
ALUMINUM, 99 Per Cent Plus	23.300

Tin Trade Quiet

Moderate business was booked in tin early in the period, attributed to covering by dealers in anticipation of somewhat better statistics for the July period. Otherwise the market was a dull affair, consumers showing little interest in either prompt or forward material. Advices from the Straits to the effect that shipments will be cut down materially in August, owing to stock-taking, caused a flurry in London on Aug. 4. Straits shipments for August are estimated at 3,250 long tons. The July statistics were about in line with expectations. London agencies that make a practice of compiling statistics reported a decrease of about 150 tons in the visible supply of tin; the New York Metal Exchange reported an increase of 81 tons.

Silver Slightly Higher

Silver prices showed little change during the period, closing the fortnight at a net gain of one-half cent. The steadiness was due to the limited quantities offered each day. Most of the offerings were absorbed for India account. The monthly average price for July was about 1c. higher than in the preceding month.

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., delivered, Alcoa commercial and mill ingot, 99 and 98 per cent, 23.30c.; Alcoa No. 12 alloy, 22c.; metallurgical ingot, 94 per cent plus, 23.30c.; 98@99 per cent, 22.90c. London, £85, less 2 per cent, per long ton, for 98 per cent ingots and bars.

Daily Prices of Metals

July Aug.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
23	7.525@7.775	24.35	4.40	4.225	3.90
24	7.400@7.525	24.125	4.40	4.225	3.875
25	7.400@7.525	24.125	4.40	4.225	3.875
27	7.525	24.20	4.40	4.225	3.85@3.90
28	7.525	24.25	4.40	4.225	3.875
29	7.525	24.25	4.40	4.225	3.875
Av'ge	7.525	24.217	4.400	4.225	3.879
30	7.375	24.175	4.40	4.225	3.85
31	7.30	24.30	4.40	4.225	3.85
1	7.275	24.35	4.40	4.225	3.85
3	7.275@7.775	24.45	4.40	4.225	3.85
4	7.275	24.85	4.40	4.225	3.85
5	7.275	24.40	4.40	4.225	3.85
Av'ge	7.338	24.421	4.400	4.225	3.850

Average prices for calendar week ended July 25, 1931, are: Copper, 7.598c.; Straits tin, 24.558c.; New York lead, 4.400c.; St. Louis lead, 4.225c.; Zinc, 3.894c.; Silver, 27.750c.

Average prices for calendar week ended August 1, 1931, are: Copper, 7.421c.; Straits tin, 24.254c.; New York lead, 4.400c.; St. Louis lead, 4.225c.; Zinc, 3.863c.; Silver, 27.854c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices of refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. The contract price for High-Grade zinc delivered in the East and Middle West is 1c. above the St. Louis price for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

Silver, Gold, and Sterling Exchange

July	Sterling Exchange "Checks"	Silver		Gold, London	July Aug.	Sterling Exchange "Checks"	Silver		Gold, London
		New York	London				New York	London	
23	4.84 1/8	27 5/8	12 15/16	84s 11 1/2d	30	4.85 3/4	28	13 1/16	84s 11 1/2d
24	4.84 1/2	27 3/4	13	84s 11 1/2d	31	4.85 1/2	27 7/8	13	84s 11 1/4d
25	4.85	27 3/4	12 11/16	.....	1	4.85 3/8	27 7/8	13	.....
27	4.85 1/16	27 7/8	13 3/16	84s 11 1/2d	3	4.85 1/2	28	Holiday	Holiday
28	4.85 3/8	27 3/4	12 15/16	84s 11 1/2d	4	4.85 5/16	28 1/8	13 1/16	84s 9 3/4d
29	4.85 1/4	27 3/4	12 15/16	84s 11 1/2d	5	4.84 1/2	28 1/4	13 1/8	84s 11 1/4d

Average for week ended July 29: Silver, 27.688c.; Sterling Exchange, $4.84885.

Average for week ended Aug. 5. Silver, 28.021c.; Sterling Exchange, $4.85323

New York quotations are as reported by Handy & Herman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command nine-thirty-seconds of a cent premium.

London

July Aug.	Copper Standard		Electrolytic (Bid)	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3 M	Spot	3 M
23	33 7/16	34 1/4	36 1/2	108 3/8	110 3/4	12 9/16	12 9/16	11 3/4	12 1/4
24	33 3/16	34	36 1/2	108 1/4	110 1/2	12 9/16	12 1/2	12	12 7/16
27	32 15/16	33 13/16	36 1/2	108 5/8	110 5/8	12 1/2	12 7/16	11 3/4	12 1/8
28	32 7/8	33 3/4	36	108 3/4	110 7/8	12 3/4	12 9/16	11 7/8	12 3/16
29	33 1/16	33 13/16	36	108 1/2	110 5/8	12 9/16	12 7/16	11 13/16	12 1/4
30	32 11/16	33 9/16	35	108 1/4	110 1/2	12 1/2	12 3/8	11 5/8	11 15/16
31	32 9/16	33 7/16	35	108	110 3/8	12 1/4	12 3/8	11 1/4	11 5/8
3				Holiday					
4	32 5/8	33 1/2	35	110 7/8	113 1/4	12 5/16	12 1/2	11 1/2	12 1/8
5	32 3/4	33 5/8	35	109	111 1/2	12 5/16	12 1/2	11 3/16	11 13/16

Prices for lead and zinc are the official price for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

ANTIMONY—Per lb., duty paid, Chinese, spot, 6.65c.; futures, 6.50c. Market continues dull and prices are barely steady. Cookson's "C" grade, spot, 11½c. "CMC" grade, 99.9 per cent, spot, 11c.

BISMUTH—Per lb., in ton lots, $1.50. London, 6s.

CADMIUM—Per lb., 55c. London, 1s. 9d.@1s. 10d.

COBALT—Per lb.: Metal imported from Belgium, 97@99 per cent, $2.50 less 35 per cent for cash. On contract for yearly requirements usual rebate of 5 to 10 per cent, as to quantity. London quotes 9s., subject to usual discounts.

IRIDIUM—Per oz., $100@$105 for 98@99 per cent sponge and powder. London, £18 to £19.

NICKEL—Per lb. electrolytic cathodes, 35c.; shot and ingot made from remelted electro, 36c. for single lots of spot metal. London, per long ton, £170 @£175, as to quantity.

PALLADIUM—Per oz., $19@$21. London, £3 12s. 6d.@£4.

PLATINUM—Per oz. Official price of leading interest, $40. Cash transactions between dealers and refiners at about $2 less. London official price £8.

QUICKSILVER—Per 76-lb. flask, $82@ $83. The prices named ranged from $83 to $87 per flask on July 30 and 31, but since then the market eased off with sales of less than 100 flasks at $83, and offerings of larger quantities at $82. London, £16 12s. 6d.@£16 15s.

Chromium, Indium, Magnesium, Manganese, Molybdenum, Osmium, Radium, Rhodium, Ruthenium, Selenium, Silicon, Tantalum, Tellurium, Thallium, Titanium, and Tungsten are unchanged from prices given in the July 27 issue.

Metallic Ores

Prices in tons of 2,000 lb., or in "Units" of 20 lb., unless otherwise stated.

CHROME ORE—Per long ton, c.i.f. Atlantic ports, Indian ores, $17 for 46@48 per cent Cr_2O_3 ore, and $19.50@$20 for 50@51 per cent ore. London, 74s.@75s. for 48 per cent Rhodesian, and 77s. 6d. @87s. 6d. for Indian and New Caledonian.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, cargo lots, exclusive of duty of 1c. per lb. of Mn contained: Indian, 48 to 50 per cent, 25@26c., nominal; South African, 52 to 54 per cent, 25@26c.; 50 to 52 per cent, 24@25c.; 44 to 46 per cent, 23½c. Caucasian, 52@55 per cent, 26@27c.

TUNGSTEN ORE—Per unit of WO_3, New York: Chinese wolframite, duty paid, $11.25. Bolivian scheelite, $11.25 @$11.50; domestic scheelite, $12. Nominal.

Antimony, Beryllium, Iron, Molybdenum, Tantalum, Tin, Titanium, Vanadium, and Zircon ores are unchanged from prices give nin the July 27 issue.

Metal Statistics

Monthly Average Prices of Metals

(See daily price table for basis of quoting)

Silver

	New York		London Spot		Sterling Exchange	
	1930	1931	1930	1931	1930	1931
January	45.000	29.423	20.896	13.810	486.447	485.260
February	43.193	26.773	20.008	12.432	485.784	485.551
March	41.654	29.192	19.298	13.524	485.933	485.596
April	42.428	28.279	19.554	13.120	486 019	485.764
May	40.736	27.650	18 850	12.858	485.724	486.188
June	34.595	27.250	16.049	12.707	485.625	486.291
July	34 346	28.255	15.928	13.197	486.300	485.425
August	35 192	.....	16.283	.....	486.839	.....
September	36 315	.....	16.738	.....	485.888	.....
October	35.846	.....	16.563	.....	485.719	.....
November	35.908	.....	16.625	.....	485.454	.....
December	32 635	.....	15 201	.....	485.413	.....
Year	38 154	.....	17 666	.....	485.929	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery Electrolytic		London Spot Standard		London Spot Electrolytic	
	1930	1931	1930	1931	1930	1931
January	17.775	9.838	71.469	44.938	83.250	47.524
February	17.775	9.724	71.419	45.372	83.500	47.950
March	17.775	9.854	69.202	44.818	83.405	47.699
April	15 621	9.392	62 075	42.694	74.338	45.375
May	12.756	8.665	53.159	38.897	59.545	42.175
June	12.049	8.025	50.003	35.827	56.750	38.966
July	11.023	7.698	48.277	34.402	52.522	37.293
August	10.693	.....	47.525	.....	50.725	.....
September	10 310	.....	46.264	.....	49.500	.....
October	9.597	.....	43.030	.....	45.772	.....
November	10.113	.....	46.134	.....	48.963	.....
December	10.300	.....	46.771	.....	50.065	.....
Year	12.982	.....	54.611	.....	61.528	.....

New York quotations, cents per pound. London, pounds sterling per long ton

Lead

	New York		St. Louis		London			
	1930	1931	1930	1931	1930 Spot	1930 3 Mos.	1931 Spot	1931 3 Mos.
January	6.250	4.802	6 100	4.604	21.545	21.571	13.872	13.905
February	6.236	4.552	6 086	4.340	21.188	21.097	13.444	13.550
March	5.662	4.527	5.542	4.276	18.807	18.940	13.128	13.355
April	5.537	4.412	5 428	4.164	18.319	18.363	12.375	12.606
May	5.523	3.818	5 408	3.651	17.795	17.861	11.491	11.778
June	5.410	3.917	5 310	3.761	17.941	17.994	11.582	11.952
July	5.250	4.400	5.149	4.225	18.160	18.063	12.731	12.899
August	5.488	.....	5.340	.....	18.294	18.178	.....	.....
September	5.500	.....	5 348	.....	17.909	17.798	.....	.....
October	5.151	.....	4.999	.....	15.747	15 674	.....	.....
November	5.100	.....	4.950	.....	15.934	15.931	.....	.....
December	5.100	.....	4 950	.....	15.283	15.292	.....	.....
Year	5.517	.....	5.384	.....	18.077	18.064	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin and Cadmium

	New York		London		Cadmium
	1930	1931	1930	1931	1931
	Straits		Spot		
January	38 851	26.137	175 466	115.798	67.115
February	38 676	26.315	173.750	117.919	55.000
March	36.798	27.065	164.851	121.852	55.000
April	36 077	25.222	162.638	112 775	55.000
May	32.108	23 221	144.818	104.331	55.000
June	30.336	23.478	136.300	104.966	55.000
July	29.822	24.978	134.511	111.478	55.000
August	30.044	.....	134.988	.....	.....
September	29.647	.....	132.631	.....	.....
October	26.802	.....	117.451	.....	.....
November	25.904	.....	113.519	.....	.....
December	25.262	.....	111.560	.....	.....
Year	31.694	.....	141.873	.....	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St Louis		London			
	1930	1931	1930 Spot	1930 3 Mos	1931 Spot	1931 3 Mos
January	5 229	4.035	19.634	20.241	12.747	13.113
February	5.180	4.012	19 209	19 778	12.303	12.694
March	4.934	4.002	18.304	18.810	12.190	12.676
April	4.843	3.717	17.819	18.378	11.353	11.838
May	4.641	3.306	16 639	17.330	10.484	10.875
June	4.441	3.416	16.422	17.038	11.270	11.750
July	4.350	3.893	16.171	16.777	12.280	12.802
August	4 360	.....	15.953	16.469	.....	.....
September	4.279	.....	15.773	16 080	.....	.....
October	4.055	.....	14 446	14.935	.....	.....
November	4.266	.....	14.706	15.238	.....	.....
December	4.099	.....	13.762	14.214	.....	.....
Year	4.556	.....	16.570	17.107	.....	.....

St. Louis quotations, cents per pound. London pounds sterling per long ton

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1930	1931	1930	1931	1930	1931
January	8.606	7.317	121.192	103.000	61.923	36.000
February	8.830	7.069	120.500	100.205	59.909	34.000
March	8.236	7.127	118.808	100.423	54.769	29.538
April	7.740	6.888	114.000	102.077	46.462	26.346
May	7.454	6.524	117.269	101.140	46.000	24.980
June	7.057	6.342	118.600	92.058	46.000	37.115
July	6.976	6.802	117.462	85.808	43.692	40.000
August	7.839	.....	116.000	.....	41.462	.....
September	7.773	.....	113.620	.....	36.080	.....
October	7.288	.....	110 596	.....	36 000	.....
November	7.105	.....	106.717	.....	36.000	.....
December	7.099	.....	105 346	.....	36.000	.....
Year	7.667	.....	115.009	.....	45.358	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce.

Pig Iron[1] and Aluminum

	Bessemer		Basic		No. 2 Foundry		Aluminum	
	1930	1931	1930	1931	1930	1931	1930	1931
Jan	19.00	17.50	18.50	17.00	18.50	17.00	24.300	23.300
Feb	19.00	17.29	18 50	16.79	18.50	16.79	24.300	23.308
March	19.00	17.00	18 50	16.50	18 50	16.50	24.300	23.300
April	19 00	17.00	18.50	16.50	18 50	16.50	24.300	23.300
May	19.00	17.00	18.50	16.38	18.50	16.44	24.300	23.300
June	19 00	17.00	18 50	15.50	18.50	16.00	24.140	23.300
July	18.62	17.00	18 12	15.50	18.12	16.00	23.300	23.300
Aug	18.50	.....	18 00	.....	18 00	.....	23.300	.....
Sept	18.38	.....	17 76	.....	17 88	.....	23.300	.....
Oct	17.85	.....	17 00	.....	17 22	.....	23.300	.....
Nov	17.50	.....	17.00	.....	17.00	.....	23.300	.....
Dec	17 50	.....	17 00	.....	17.00	.....	23.300	.....
Year	18 53	.....	17 99	.....	18.02	.....	23.787	.....

Iron in dollars per long ton. Aluminum in cents per pound, 99 per cent grade.

[1]F.o.b. Mahoning and Shenango valley furnaces; freight to Pittsburgh, $1.76.

Monthly Crude Copper Output in Short Tons

Domestic

	1929 Total	1930 Total	1931 Mar.	1931 Apr.	1931 May	1931 June
Alaska shipments	21,947	18,953	563	885	1,215	1,303
Calumet & Arizona	65,246	45,161	3,189	.....	.....	.....
Magma	19,118	15,940	1,223	1,213	1,208	1,437
Miami	29,567	34,568	2,025	1,995	2,272	2,174
Nevada Cons	133,140	70,990	(d) 16,393	.....	.....	.....
Old Dominion (a)	11,172	10,428	580	587	992	609
Phelps Dodge (b)	111,026	72,308	5,188	5,180	5,176	5,178
United Verde Extens	29,669	21,908	1,618	1,537	1,685	1,642
Tennessee Corp	7.870	7,772	611	609	992	833

Foreign

Andes Copper	60,538	47,428	3,498	3,503	3,498	.....
Braden	88,155	79,923	8,596	8,597	8,594	.....
Boleo, Mexico	12,898	13,940	(d) 3,250	.....	.....	(c) 3,107
Chile	150,247	89,100	7,117	7,121	7,117	.....
Furukawa, Japan	17,767	18,536	1,563	1,624	1,517	.....
Howe Sound	21,516	22,633	(d) 4,013	.....	.....	(c) 4,001
Mesina	(c) 7,100	(c) 7,600	843	764	868	870
Mt. Lyell	9,731	10,878	(d) 2,699	.....	.....	.....
Sumitomo, Japan	20 180	15,429	1,400	1,236	1,571	.....

(a) Includes Arizona Commercial. (b) Moctezuma is included. (c) Fiscal year. (d) Three months

Monthly Production of Primary Copper from U. S. Mines and Daily Rate (Short Tons)

	1929 Monthly Production	1929 Daily Rate	1930 Monthly Production	1930 Daily Rate	1931 Monthly Production	1931 Daily Rate
January	86.324	2.785	67,838	2,188	48,059	1,550
February	84.735	3,026	59,196	2,114	47,504	1,697
March	93,698	3,023	61,216	1,975	48,702	1,571
April	94.902	3,163	60.450	2,015	46,452	1,548
May	93.392	3,013	60.238	1,943	45.671	1,470
June	82.354	2,745	56.743	1,891	44,647	1,488
July	79.229	2,556	54,249	1.750	.....	.....
August	78.885	2,545	56,779	1,832	.....	.....
September	79.402	2,647	56.584	1,886	.....	.....
October	82.575	2,664	55,954	1,805	.....	.....
November	75.934	2,531	53,141	1,771	.....	.....
December	74.772	2,412	48,518	1,565	.....	.....
Total	1,006.203	.....	690.263	.....	280,944	.....
Monthly average	83,850	.....	57 522	.....	46,824	.....
Av. of daily rate	.....	2.757	.....	1,891	.....	1,552

Mining Share Prices—Month of July, 1931

Company Name	High	Low	Last	§Most Recent Dividend
NEW YORK STOCK EXCHANGE				
Alaska Juneau	0.16⅞	$0.12	$0.14½	Jy. 10, Au. 1, 1931....Q 0.10
American Metal	15½	9⅜	10⅞	December, 1930.....Q 0.25
Am. Metal, pfd	.....	.....	53½*	Au. 22, Se. 1, 1931.....Q 1.50
Am. Sm. & Ref	38⅞	30⅛	31⅝	Jy. 10, Au. 1, 1931.....Q 0.50
Am. Sm. & Ref. 2nd pfd.	93	92	92	Au. 7. Se. 1, 1931.....Q 1.50
Am.Sm. & Ref. 1st pfd.	129	120½	126½	Au. 7, Se. 7, 1931.....Q 1.75
Am. Zinc., L. & S.	6½	4⅜	5	May, 1917..... 1.00
Am. Zinc, L. & S., pfd.	41⅛	39	41¼	October, 1930.....Q 1.50½
Anaconda	31⅝	22⅜	25½	Jy. 11, Au. 17, 1931.....Q 0.37½
Andes Copper	13	12	12	Ja. 10, Fe. 9, 1931.....Q 0.25
Butte C. & Z.	2⅜	2	2	December, 1929..... 0.50
Butte & Superior	1	0.87½	0.87½	December, 1929.....Q 0.50
Callahan Zinc-Lead	62½	50	50	December, 1920..... 0.50
Cal. & Arizona	41⅝	32⅜	37	June, 1930..... 0.50
Cal. & Hecla	8⅜	6⅜	6¾	June, 1930..... 0.50
Cerro de Pasco Copper	22	15⅜	16	Jy. 16, Au. 1, 1931.....Q 0.25
Dome Mines	12⅜	11⅛	11¼	Je. 30, Jy. 20, 1931.....Q 0.25
Federal M. & S.	42	42	42	June, 1927.....10.00
Federal M. & S., pfd.	75	70	75	My. 25, Je. 5, 1931.....Q 1.75
Freeport Texas	29⅛	23⅜	26	My. 15, Je. 1, 1931.....Q 0.75
Granby Con	16⅞	12½	12⅜	Jy. 17, Au. 1, 1931.....Q 0.25
Greene Cananea	.....	.....	73½*	July. 1930..... 0.75
Homestake	100½	89⅞	100	Jy. 20, Jy. 25, 1931....M0.50
Howe Sound	22½	19	19	Je. 30, Jy. 15, 1931....Q 0.50
Inspiration	8⅜	6⅜	7⅜	July, 1930..... 0.50
International Nickel	16½	12	12	Je. 1, Je. 30, 1931.....Q 0.15
Int. Nickel, pfd	119	117	119	Jy. 2, Au. 1, 1931.....Q 1.75
Kennecott Copper	23⅜	16½	18⅜	Je. 11, Jy. 1, 1931.....Q 0.25
McIntyre Porcupine	22⅜	21⅜	21⅜	Au. 1, Se. 1, 1931.....Q 0.25
Magma Copper	16½	13¼	14	Je. 30, Jy. 15, 1931.....Q 0.25
Miami Copper	8½	5⅜	6½	August, 1930..... 0.375
Mother Lode	62½	50	50	June, 1930..... 0.50
National Lead	122	104	104	Se. 11, Se. 30, 1931.....Q 1.25
National Lead, pfd. A	141½	140	140	Au. 28, Se. 15, 1931.....Q 1.75
National Lead, pfd. B	120	117½	118	Oc. 16, No. 2, 1931.....Q 1.50
Nevada Con	12⅜	8⅜	8⅞	Je. 12, Je. 30, 1931.....Q 0.25
Noranda Mines	21⅜	17⅜	18½	October, 1930..... 0.50
Park Utah Con	1½	1⅛	1⅛	July, 1929.....Q 0.20
Patiño M. & E.	12⅜	7⅜	7⅜	December, 1929..... 4s.
Phelps Dodge	16	11⅜	11⅝	Je. 18, Jy. 1, 1931.....Q 0.25
Rand Mines	30	30	30	August, 1930..... 1.52
St. Joseph Lead	21½	16⅛	16⅛	Se. 10, Se. 21, 1931.....Q 0.25
Seneca Copper	1⅜	1	1⅛	.....
Tennessee Corp	7⅛	6	6	Fe. 28, Mh. 16, 1931...Q 0.125
Texas Gulf Sulphur	39½	32¼	33⅜	Se. 1, Se. 15, 1931.....Q 0.75
U. S. S. R. & M.	19½	16	16	Jy. 2, Jy. 15, 1931.....Q 0.25
U. S. S. R. & M., pfd.	43	41	41½	Jy. 2, Jy. 15, 1931.....Q 0.87½
Utah Copper	103	100	100	Je. 12, Je. 30, 1931.....Q 1.50
Vanadium Corp.	38⅛	25⅜	27¼	Fe. 2, Fe. 16, 1931.....Q 0.75
NEW YORK CURB EXCHANGE				
Aluminum Co. of Am.	146½	108½	114	.....
Alum. Co. of Am., pfd.	104	95½	102	Mr. 14, Ap. 1, 1931....Q 1.50
Anglo-Chilean Con	6¼	50	1⅜	4 shares Cosach B...June, 1931
Bunker H. & S.	36	33⅜	34	My. 29, Je. 5, 1931.....0.25
Carnegie Metals	1⅜	1	1⅛	.....
Comstock Tunnel	0.62½	0.50	0.62½	.....
Con. Coppermines	2⅜	2⅛	2⅛	.....
Copper Range	.....	.....	5*	July, 1930..... 0.25
Cresson Consolidated	0.50	0.37½	0.37½	Je. 30, Jy. 10, 1931.....Q 0.01
Cusi Mexicana	0.62½	0.37½	0.37½	.....
Evans-Wallower	0.87½	0.62½	0.62½	.....
Federated Metals	8⅛	8	8	Ja. 5, Ja. 15, 1931.....Q 0.25
Hecla Mining	6	5⅛	5⅛	Je. 30, Jy. 15, 1931.....Q 0.10
Hollinger Consolidated	6⅜	5⅜	5⅞	Jy. 29, Au. 12, 1931.....Q 0.05
Hudson Bay M. & S.	5⅜	3⅜	3⅜	.....
Iron Cap Copper	.....	.....	0.75*	.....
Mayflower Associates	34	32	32	Je. 1, Je. 15, 1931.....Q 0.50
Mining Corporation	.....	.....	2*	December, 1929..... 0.12½
New Jersey Zinc	43	39	39	Jy. 20, Au. 10, 1931.....Q 0.50
Newmont Mining	36½	26⅜	27	Mh. 31, Ap. 15, 1931..Q 1.00
N. Y. & Honduras Roas.	10⅜	10⅛	10⅛	Jy. 21, Jy. 31, 1931.....Q 0.25
Nipissing	1⅛	1	1	Mh. 31, Ap. 20, 1931..Q 0.075
Ohio Copper	0.31⅛	0.18⅜	0.18⅜	September, 1926..... 0.03
Premier Gold	0.75	0.62½	0.62½	Je. 11, Jy. 3, 1931.....Q 0.03
Quincy	4⅞	4⅛	4⅞	March, 1920..... 1.00
Shattuck Denn	4⅜	3⅛	3⅛	.....
So. Am. Gold & Plat.	1⅞	1⅛	1⅛	.....
Teck-Hughes	6⅜	6⅜	6⅜	Jy. 18, Au. 1, 1931.....Q 0.15
Tonopah Mining	0.50	0.50	0.50	October, 1929..... 0.07½
United Eastern	.....	.....	0.06⅛*	.....
United Verde Ex	13⅜	8⅜	9½	Jy. 2, Au. 1, 1931.....Q 0.75
Utah-Apex	1⅛	1	1	December, 1929..... 0.025
Yukon Gold	0.12½	0.12½	0.12½	June, 1918..... 0.02
BOSTON STOCK EXCHANGE				
Isle Royale	4	2½	2⅜	March, 1930..... 0.50
Mohawk Mining	17	15	15½	Jy. 31, Au. 29, 1931.....Q 0.25
Old Dominion	3½	2	2	December, 1918..... 1.00
Utah Met. & Tunnel	0.48	0.30	0.30	December, 1927..... 0.30
MONTREAL				
Asbestos Corp	.....	.....	0.25*	January, 1926..... 1.50
Asbestos Corp., pfd	.....	.....	0.50*.	January, 1930..... 1.75
Consolidated M. & S.	114½	88½	99	Je. 23, Jy. 15,1931....SA 1.25

Company Name	High	Low	Last	§Most Recent Dividend
SPOKANE				
Constitution	.....	.....	0.06¾*	.....
Dayrock	.....	.....	0.95*	March, 1930..... 0.03
Golconda	0.25½	0.21¼	0.21½	July, 1929..... 0.02
Jack Waite Con	0.39½	0.34	0.34	.....
Los Lugos	.....	.....	0.01¾*	.....
Mexican Premier	0.16	0.12½	0.16	January, 1930..... 0.01
Montana Mines	0.13	0.09¼	0.09¾	.....
Noble Five	.....	.....	0.03*	January, 1930..... 0.005
Pend Oreille	.....	.....	0.65*	.....
Sherman Lead	0.32	0.32	0.32	March, 1930..... 0.01
Sidney	.....	.....	0.05*	October, 1929..... 0.01
Sunshine Mining	1.10	0.94	0.96	December 20, 1930.....Q 0.03
Tamarack & Custer	0.21¾	0.21¾	0.21¾	September, 1924..... 0.25
SALT LAKE CITY				
Chief Con	0.53	0.43½	0.45	February, 1928..... 0.10
Combined Metals	0.08½	0.08½	0.08½	.....
Eureka Bullion	0.21	0.16½	0.16½	.....
Eureka Lilly	0.15	0.12	0.12½	.....
Moscow Silver	0.46	0.46	0.46	.....
New Quincy	0.13½	0.07	0.09½	September, 1929.....Q 0.10
North Lily	1.05	0.80	0.80	January, 1930..... 0.15
Park Bingham	0.02¾	0.02	0.02½	.....
Park City Con	0.17	0.13	0.14	.....
Rico Argentine	0.04½	0.04	0.04	December, 1929..... 0.03
Silver King Coalition	4.75	4.30	4.60	De. 20, Ja. 2, 1931.....Q 0.15
Tintic Lead	1.05	0.93	0.98	.....
Tintic Standard	3.75	3.25	3.30	Je. 29, Jy. 31, 1931....Q 0.10
Walker Mining	1.27½	1.12½	1.15	April, 1930..... 0.075
¶ TORONTO				
Abana Mines	0.07½	0.03	0.06½	.....
Amulet Mines	0.23	0.16	0.16	.....
Base Metals	1.15	1.00	1.00	.....
Barry-Hollinger	0.11	0.09	0.09½	.....
Canam Metals	0.03	0.03	0.03	.....
Castle-Trethewey	0.17	0.15½	0.15½	.....
Central Manitoba	0.13	0.10	0.12½	.....
Falconbridge	1.35	1.06	1.06	.....
Granada Rouyn	1.40	1.25	1.32	.....
Howey Mines	0.32	0.27	0.31½	.....
Keeley	0.23	0.23	0.23	March, 1928..... 0.04
Kirkland Lake	0.67	0.55½	0.60	.....
Lake Shore	27.40	26.05	26.15	Je. 1, Je. 15, 1931....QB 0.60
Sherritt Gordon	0.75	0.60	0.63½	.....
Siscoe Gold	0.48½	0.46	0.47	.....
Sylvanite	0.72½	0.65	0.66	De. 5, De. 20, 1930...SA 0.02
Treadwell Yukon	1.25	1.25	1.25	.....
Ventures	0.55	0.40	0.42	.....
Vipond Con	0.80	0.70	0.72	April, 1927..... 0.03
Waite-A.-M	1.35	1.10	1.19	.....
Wright-Hargreaves	2.82	2.68	2.78	Je. 15, Je. 30, 1931.....Q 0.05
ST. LOUIS, CINCINNATI, AND DENVER				
Consolidated L. & Z	2.00	2.00	2.00	December, 1929..... 0.125
Eagle-Picher	5.25	5.25	5.25	April, 1930..... 0.20
Eagle-Picher, pfd	.....	.....	80*	De. 31, Ja. 15, 1931....Q 1.50
Empire Chief	0.005	0.005	0.005	.....
Star of Utah	0.20	0.18	0.18½	.....
Tungsten Prod	0.07½	0.04½	0.07½	.....
West Gold	0.37½	0.34	0.37½	.....
SAN FRANCISCO, LOS ANGELES, AND COLORADO SPRINGS				
California Copper	0.50	0.37½	0.50	.....
(a)Golden Cycle	14¾	14	14	Au. 31, Se. 10, 1931.....Q 0.50
(a)Granite Gold	0.20	0.18	0.20	Je. 22, Jy. 1, 1931.....Q 0.01
Idaho-Maryland	0.55½	0.51	0.54	.....
Tom Reed	0.84	0.74	0.76	Je. 10, Jy. 1, 1931.....Q 0.05
(a)United Gold	0.07½	0.06½	0.07½	February, 1930..... 0.01

‡ LONDON

Company Name	High	Low	Last	Most Recent Dividend (Per Cent, Unless Noted)
Anglo American	13/6	11/6	12/–	22½, Feb. 19, 1930
Aramayo Mines	21/3	17/9	18/9	5, Oct. 23, 1929
Burma Corporation	8/10½	7/4½	7/7½	1¼, Dec. 10, 1930(b)
Camp Bird	4/10½	5/7½	3/9	16¾, April 25, 1928
Fresnillo	10/–	8/9	8/9	25 cents, Feb. 12, 1930
Frontino & Bolivia	11/10½	11/3	11/3	2½, July 1, 1931
Lake View & Star	10/–	8/–	8/3	11¼, 1921
Mexican Corporation	5/3	2/10½	4/–	10, Oct 24, 1929
Oroville Dredging	1/9	1/7½	1/9	37½, May 16, 1930
Rhokana Corporation	105/–	77/6	77/6	.....
Rhodes.-Select. Trust	12/3	9/4½	9/4½	.....
Rio Tinto	477/6	342/6	352/6	10s, May 1, 1931
St. John del Rey	18/4½	17/10½	18/–	8½, May 1, 1931
San Francisco Mines	12/9	9/6	11/–	10, Jan. 7, 1931
Santa Gertrudis	7/6	6/3	6/6	9d., July 9, 1931
Selukwe	2/6	1/10½	2/1½	6¼, April 2, 1917
So. American Copper	1/10½	1/3	1/3	.....
Tanganyika	26/10½	18/4½	20/–	2½, Aug. 2, 1930
Wiluna Gold	17/9	14/9	15/–	.....
Union Minière	4,925	3,885	4,350†	240 francs, July, 1931

Salt Lake Stock Exchange courtesy J. A. Hogle & Company, Spokane Standard Exchange courtesy the Pohlman Investment Company. *Not traded in †Belgian Francs. ‡The above London quotations are for the month ended July 24. ¶Toronto prices are for the month ended July 31. Q, quarterly; I, initial; M, monthly; X, extra; SA, semi-annual; L, liquidating; B, plus bonus. §Total dividends paid during the month will be found tabulated in the Market and Financial News Section. Dates here given are those of closing of books and payment of dividend. (a) Bid prices. (b) 1¼% (2 annas) dividend, and bonus of ¼% (1 anna). (c) Closing bid prices.